Metals & Non-Metals

Handwritten Notes

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Gaurav Suthar

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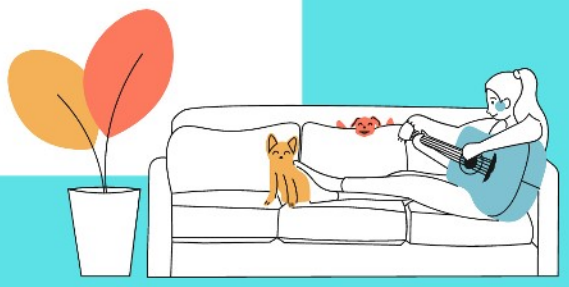

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METALS

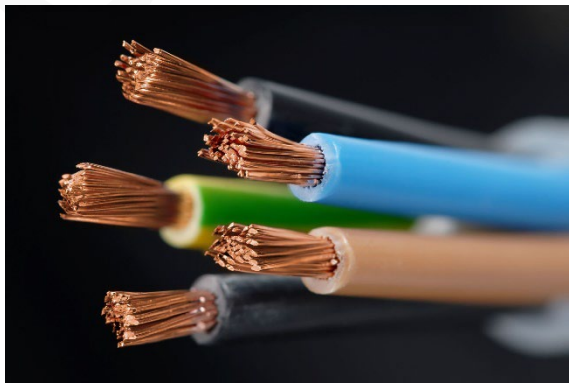
Those elements which form positive ions by losing electrons are called Metals.

Physical Properties of Metals -

1. Good Conductor of Heat and Electricity.
2. High melting and Boiling Point
3. Solid at room temperature except mercury (liquid)
4. Are Sonorous (means they produce a sound on striking)
5. Are Malleable, i.e., they can be hammered into thin sheets.
6. Are Ductile (means they can be used to make wires)

Gold is the most ductile metal means wires of gold can be made easily because gold is very soft for bending.

But we can't use Wires of Gold in our Home (क्यूंकि Gold इतना महँगा है की पूरा घर ही बिक जाएगा 😂)



Copper Wire

Gold Wire

Chemical properties of Metals -

1. Reaction of Metals with Oxygen -

Metal + Oxygen → Metal Oxide

Examples -

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

$$2Cu + O_2 \rightarrow 2CuO$$

Different metals react in different ways with O_2

i) Metals like Potassium and Sodium react so strongly with Oxygen that they catch fire if kept in open. So they are kept in Kerosene oil to avoid accidental fires.

Sodium stored in Kerosene

Magnesium covered with Oxide layer

ii) At room temperature, surfaces of metals such as Magnesium, Aluminium, Zinc etc. are covered with a thin layer of oxide, to prevent further oxidation.

iii) Silver and Gold do not react with oxygen even at high temperatures.

Amphoteric Oxides - Metals oxides which react with both acids as well as bases to produce salts and water are called Amphoteric Oxides.

Examples -

$$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + H_2O$$

$$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$$

2. Reaction of Metals with Water -

$$\text{Metal} + \text{Water} \rightarrow \text{Metal Oxide} + \text{Hydrogen}$$

$$\text{Metal Oxide} + \text{Water} \rightarrow \text{Metal Hydroxide}$$

i) For Sodium (Na) and Potassium (K) - Reaction is violent even with cold water and so exothermic that hydrogen immediately catches fire.

Examples -

$$2Na + 2H_2O \rightarrow 2NaOH + H_2 + \text{Heat}$$

$$2K + 2H_2O \rightarrow 2KOH + H_2 + Heat$$

ii) For Calcium (Ca) - Reaction is less violent for hydrogen to catch fire.

Examples -

$$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$$

iii) For Aluminium (Al) and Iron (Fe) - These do not form hydroxide as their oxides are not soluble. They do not react with hot water but with steam.

Examples -

$$2Al + 3H_2O \rightarrow Al_2O_3 + 3H_2$$

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$$

3. Reaction of Metals with Acids -

Metal + Dilute Acid → Salt + Hydrogen

Examples -

$$Fe + 2HCl \rightarrow FeCl_2 + H_2$$

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

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

Some metals like Silver, Gold and copper do not react with acid.

4. Reaction of Metals with Solutions of other Metal Salts -

Metal A + Salt Solution B → Salt Solution A + Metal B

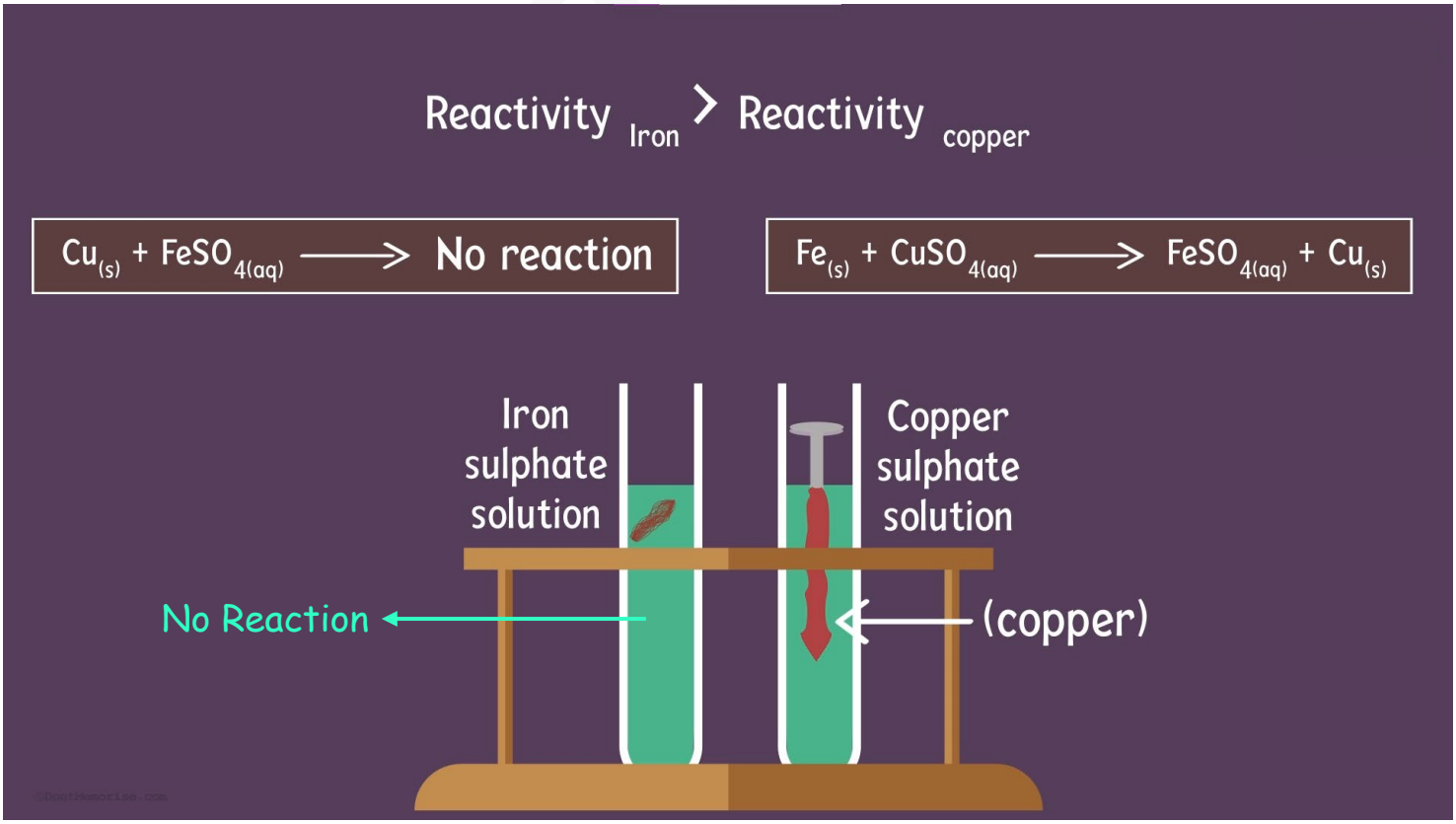
Only more reactive metal can displace a less reactive metal from compound.

Examples -

$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$

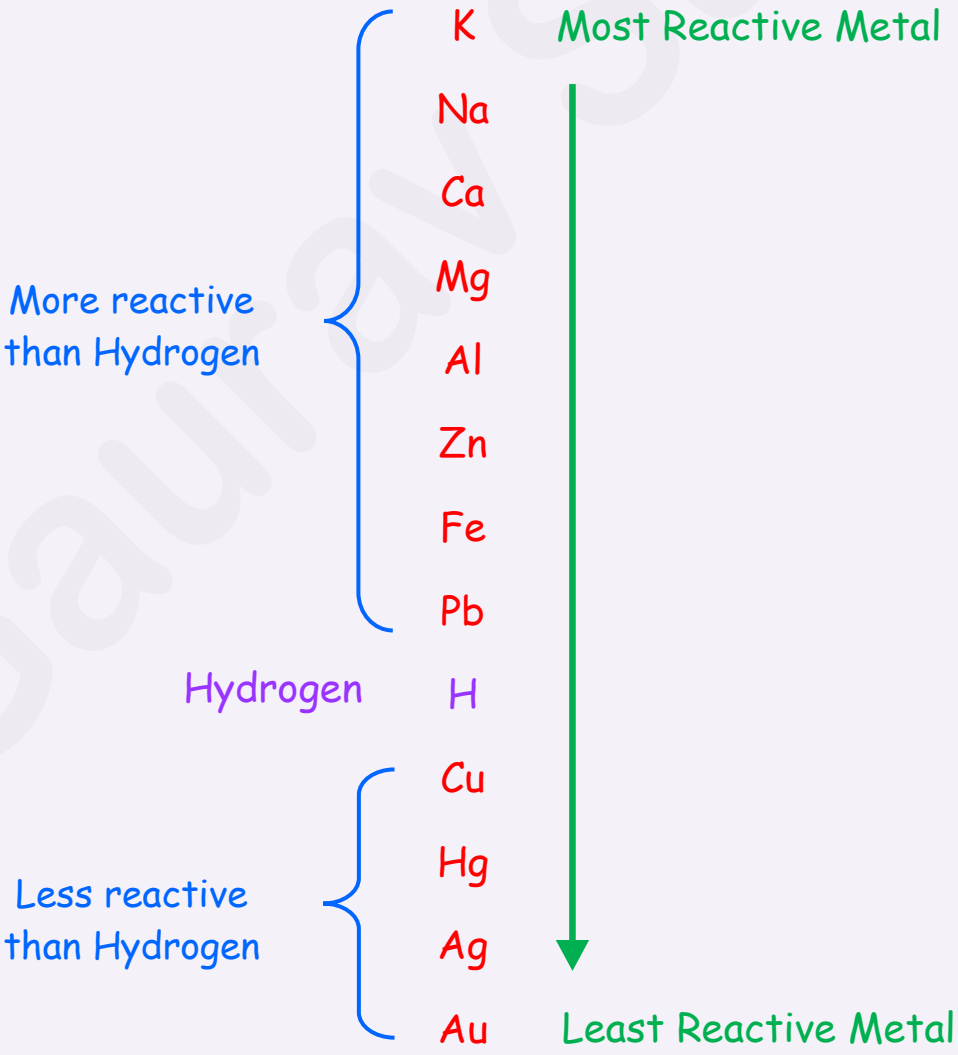
$Cu + FeSO_4 \rightarrow$ No Reaction

(Because Cu is less reactive than Fe)



Reactivity Series

Reactivity Series is a list of metals arranged in order of their decreasing activities



NON - METALS

Those elements which form negative ions by gaining electrons are called Non-Metals.

Physical Properties of Non - Metals -

1. Are solids or gases except Bromine (liquid)
2. Low melting and Boiling Point
3. Bad conductor of Heat and Electricity (except Graphite)
4. Are Non - Sonorous (don't produce a sound on striking)
5. Are Non – Malleable (brittle), means they will break when hammered or stretched
6. Are Non – Ductile.

Chemical properties of Non - Metals -

1. Reaction of Non-Metal with Water -

Non-Metal + Water → No Reaction

2. Reaction of Non-Metals with Acids -

Non-Metal + Acid → No Reaction

3. Reaction of Non-Metals with Oxygen -

Non-Metal + Oxygen → Non-Metal Oxide

Examples -

$C + O_2 \rightarrow CO_2$

4. Reaction of Non-Metals with Metal -

Non-Metal + Metal → Salt/ Metal Oxide

Examples -

$Na + Cl \rightarrow NaCl$

Ionic - Compounds

The compounds formed by the transfer of electrons from a metal to a non-metal are called Ionic Compounds.

Properties of Ionic Compounds -

1. They are Solid and Hard
2. High Melting and Boiling Point
3. Soluble in Water and insoluble in Petrol, Kerosene

4. Good Conductors of electricity in Aqueous Solution and Molten state but do not conduct in Solid state.

Examples –

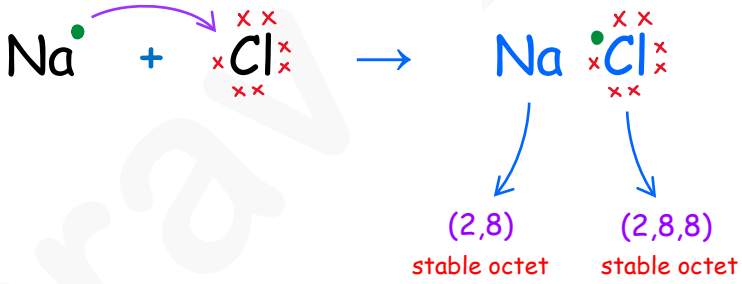
Formation of NaCl

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

(2,8,1) → (2,8) stable octet

$Cl + e^- \rightarrow Cl^-$

(2,8,7) → (2,8,8)



Common Salt - (Tata Salt - देश का नमक 😜)

Occurrence of Metals

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

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

Very Reactive Metals	K, Na, Ca, Mg, Al	Not found in free state Extraction by electrolysis
Moderately Reactive	Zn, Fe, Pb, Cu, Hg	Occur as sulphides, oxides, carbonates Reduction by using carbon
Least Reactive	Ag, Au	Occur in free state

Extraction of Metals from Ores

Step 1) Enrichment of Ores.

Step 2) Extraction of Metals.

Step 3) Refining of Metals.

Ore

↓

Concentration of Ore

Metals with High reactivity

↓

Electrolysis of Molten Ore

↓

Pure Metal

Metals of Medium reactivity

Carbonate Ores

$ZnCO_3$

↓

Calcination

Sulphide Ores

ZnS

↓

Roasting

↓

Oxides of Metal

↓

Reduction to Metal

↓

Purification of Metal

Metals with Low reactivity

↓

Sulphide Ores

↓

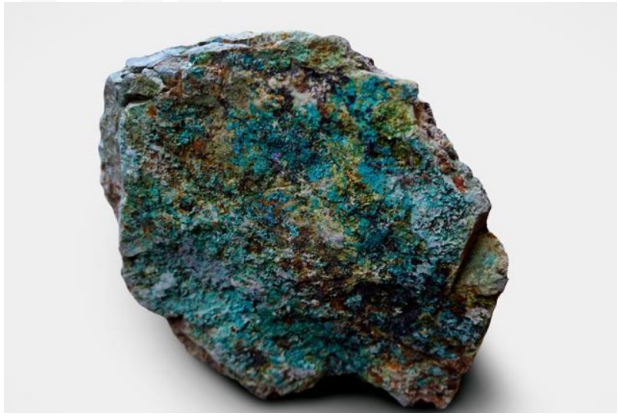
Roasting

↓

Metal

↓

Refining



Carbonate Ores

Sulphide Ores

Steps involved in Extraction of Metals from Ores

Some Important Terms

a) Gangue - Ores are usually contaminated with large amount of impurities such as soil, sand etc. This is called gangue.

b) Roasting - The sulphide ores are converted into oxides by heating strongly in the presence of excess air.

$$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$$

c) Calcination - The carbonate ores are changed into oxides by heating strongly in limited air.

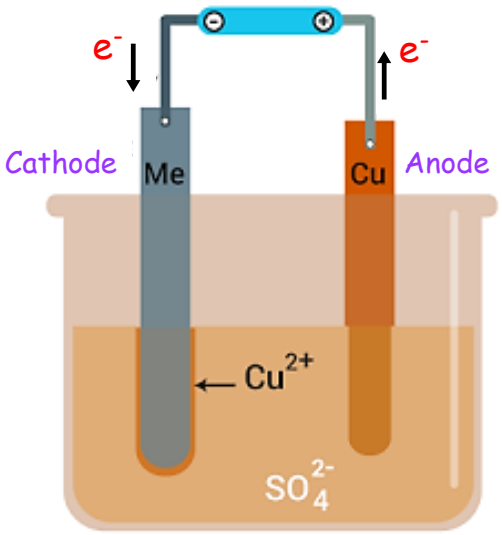
$$ZnCO_3 \rightarrow ZnO + CO_2$$

d) Reduction - Metal oxides are reduced to corresponding metals by using reducing agent like carbon.

$$ZnO + C \rightarrow Zn + CO$$

Refining of Metals

The most widely used method for refining impure metal is electrolytic refining.



Anode - Impure copper

Cathode - Strip of pure copper

Electrolyte - Solution of acidified copper sulphate

a) On passing the current through electrolyte, the impure metal from anode dissolves into the electrolyte.

b) An equivalent amount of pure metal from the electrolyte is deposited at cathode.

c) The insoluble impurities settle down at the bottom of the anode and is called anode mud.

Corrosion

The surface of some metals such as iron is corroded when they are exposed to moist air for a long period of time.

i) Silver becomes black when exposed to air as it reacts with air to form a coating of silver sulphide.

ii) Copper reacts with moist carbon dioxide in the air and gains a green coat of copper carbonate.

iii) Iron when exposed to moist air acquires a coating of a brown color called Rust.

Prevention of Corossion

The rusting of iron can be prevented by painting, oiling, greasing, galvanizing, chrome plating, or make alloys.

Galvanization - It is a method of protecting steel and iron from rusting by coating them with a thin layer of zinc.

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

Iron - Mixed with small amount of carbon becomes hard and strong.

Steel - Iron + Nickel and Chromium

Brass - Copper + Zinc

Bronze - Copper + Tin

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