

# Metals and Non-metals

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## Metals

- **Physical properties**
- Shining surface (in pure state) [called metallic lustre]
- Generally hard [varies from metal to metal]
- Malleable [i.e. can be made thin sheets by beating]
- Ductile [i.e. can be drawn into thin wires]
  - [Gold → Highly ductile]
- Good conductors of heat
- High melting point
- Conduct electricity
- Produce sound [some metals; these are called sonorous]

## Non-metals

- Non-metals are found in all the three states i.e. solid, liquid and gas, at room temperature.
- Iodine (non-metal) has lustre
- Carbon has allotropes (exists in different forms)
  - Diamond is hard
  - Graphite (Conducts electricity)

Metals	Non-metals
Generally, these are hard and lustrous.	These are soft and have no lustre.
These are malleable and ductile (Malleable: can be beaten into sheets; Ductile: can be drawn into wires).	These are non-malleable and non-ductile.
These are sonorous (produce ringing sound when struck).	These are not sonorous.
These are good conductors of heat and electricity.	These are poor conductors of heat and electricity.

- **Chemical properties:**

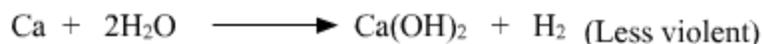
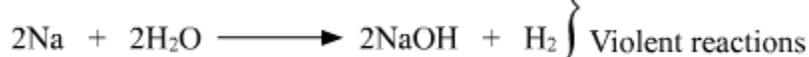
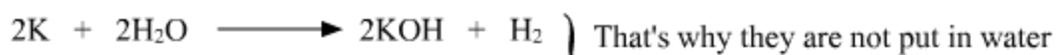
Metals	Non-metals
These react with oxygen to produce metal oxides, which are basic in nature.	These react with oxygen to form non-metallic oxides, which are acidic in nature.

## Chemical properties

- **Reaction with oxygen**
- **Combine with oxygen to form oxides**
- $2\text{Cu} + \text{O}_2 \rightarrow 2\text{CuO}$
- $4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3$
- Most metal oxides are insoluble in water.
- If soluble, they form alkali.
- $\text{Na}_2\text{O} + \text{H}_2\text{O} \rightarrow 2\text{NaOH}$

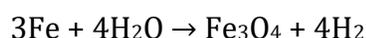
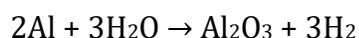


- Sodium, potassium react very easily with  $\text{O}_2$ . So, they are kept immersed in kerosene.
- Mg, Al, Zn, Pb form thin layers of oxides.
- **Reaction with water**
- Produce metal oxide +  $\text{H}_2$
- If oxide is soluble, then metal hydroxide is formed.



Mg → Doesn't react with cold  $\text{H}_2\text{O}$

- Al, Zn, Fe do not react with  $\text{H}_2\text{O}$ , but react with steam.



- **Chemical properties:**

Metals	Non-metals
These react with acids to produce metal salts and hydrogen gas.	These do not react with acids.
Some metals react with bases to produce hydrogen gas.	Reactions of non-metals with bases are complex.

### Reaction with Acids

- Metal + Dilute acid → Metal salt +  $\text{H}_2$
- $\text{H}_2$  doesn't evolve in the case of  $\text{HNO}_3$  as it is a strong oxidising agent. It oxidises  $\text{H}_2$ .
- Cu does not react with acids like dilute  $\text{H}_2\text{SO}_4$  and dilute HCl.
- **Aqua regia**
- Freshly-prepared concentrated HCl and concentrated  $\text{HNO}_3$  in 3:1 ratio

- It can dissolve gold and platinum.

### **Reaction with Bases**

- Metals react with bases to produce hydrogen gas.
- Reactions of non-metals with bases are complex.

### **Corrosion:**

The process of breaking down of metals because of their reactions with moisture and gases present in the air is known as corrosion. Rusting of iron is the most common example of corrosion.

### **Factors Affecting Corrosion**

- Reactive nature of metal: Highly reactive metals corrode easily.
- Presence of dissolved salts: They act as electrolyte and increase the rate of corrosion.
- Presence of pollutants: They increase the rate of corrosion.
- Presence of less reactive metal: If a less reactive metal is present, it will make the more reactive metal susceptible to corrosion.

### **Methods to prevent corrosion:**

- Rusting can be prevented by painting, oiling, and greasing of iron articles. In fact, paints and grease should be applied regularly to prevent rusting.
- Rusting can also be prevented by applying a layer of a metal such as chromium or zinc on the surface of iron articles. **The process of depositing zinc on iron is called galvanization.**
- Rusting can also be prevented by connecting the iron object with a more reactive metal like zinc with the help of a wire. **The process of connecting iron with a more reactive metal through a wire is called cathode protection.**
- Alloying can also be used to prevent rusting or corrosion.

### **Alloys**

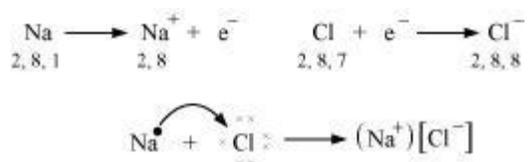
An alloy is a homogeneous mixture of two or more elements, at least one of which is a metal. Some common alloys are stainless steel (iron+nickel+chromium), brass (copper+zinc) and bronze (copper+tin).

- **Reactivity  $Mg > Al > Zn > Fe > Cu$**
- **Reaction with solutions of other metal salts**
- Displacement reactions
- $Metal\ A + Salt\ solution\ of\ B \rightarrow Salt\ solution\ of\ A + Metal\ B$
- Reactivity series
- **Main Features of Reactivity Series**
- Metals are arranged in the decreasing order of their electropositive character.

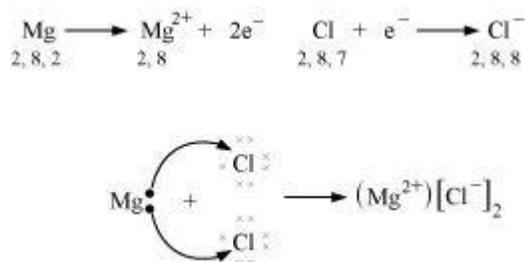
- Metals at the top have greater reducing power. This power decreases on moving down the series.
- Metals at the top show greater tendency to get oxidised.
- Metals above hydrogen in the reactivity series liberate hydrogen gas from mineral acids.
- Metals at the top displace metals lower in the series from the aqueous solution of their salts.
- Metal oxides above Al, cannot be reduced by common reducing agents, the reverse is true for metal oxides below Al.
- **K > Na > Ca > Mg > Al > Zn > Fe > Pb > H > Cu > Hg > Ag > Au**

- **Metals + Non-metals**

- **1)**



- **2)**

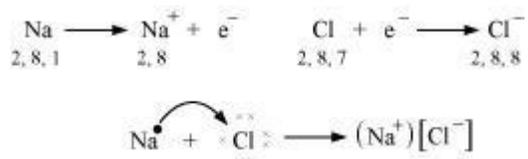


- **Physical Properties of Ionic compounds**

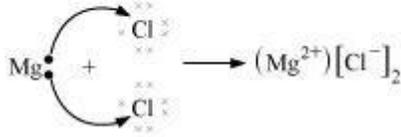
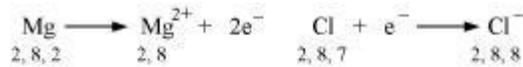
1. Solid
2. Hard [because of strong attraction force]
3. Brittle
4. High melting and boiling points
5. Soluble in H<sub>2</sub>O; insoluble in kerosene, petrol
6. Conduct electricity in H<sub>2</sub>O solution

- **Metals + Non-metals**

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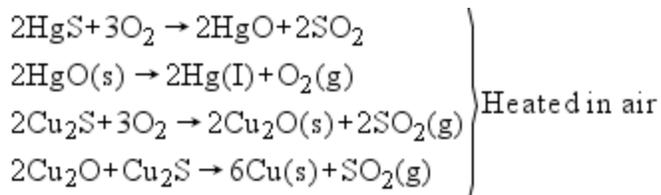
Elements on earth are found in different parts of earth and are found in different forms. Different parts of earth include lithosphere, hydrosphere and atmosphere.

- Elements or compounds, which occur naturally in the Earth's crust, are known as minerals.

- **Extraction of metals**

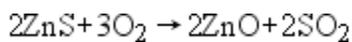
K Na Ca Mg Al	Zn Fe Pb Cu	Ag Au
Highly reactive metals	Medium reactive metals	Found in native form
—	—	
Electrolysis	Carbon reduction	

- **Low active metals**

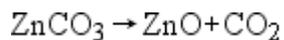


- **Middle active metals**

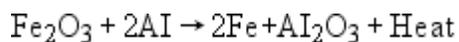
- **Roasting** – Heating of sulphide ore in **excess air**



- **Calcination** – Heating of carbonate ores in **limited air**



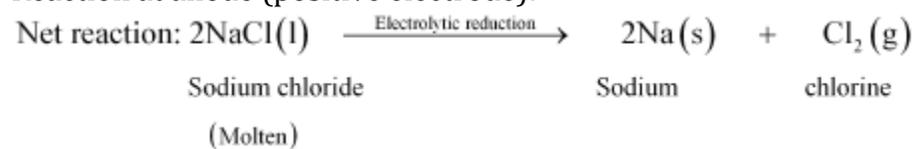
- **Thermite reaction**



- **Electrolytic Reduction**

Reaction at cathode (negative electrode):  $\text{Na}^+ + \text{e}^- \rightarrow \text{Na}$

Reaction at anode (positive electrode):  $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$



- **Electrolytic refining of metals**
  - Impure metal is made the anode and thin strip of pure metal is made cathode.
  - A solution of metal salt is used as an electrolyte