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Ch-3
Metals and Non-Metals.

Metals - Those elements which form positive ions by losing electrons are called metals. Ex - Na, Ca, Cu, Al, Zn, etc.

Physical properties of metals.

→ Hardness → Generally all metals are hard.
except ⇒ sodium, potassium, Lithium

→ Malleability ⇒ It is the property of metal due to which metal can be beaten into thin sheet. Except - mercury (Hg)
• Gold and silver are most malleable metals.

→ Ductility ⇒ It is the property due to which metal can be drawn into thin wires. Gold is the most Ductile metal. 2Km length of wire can be drawn from one gram of gold.

→ Metallic lustre ⇒ In pure state metals are shiny mostly.
platinum, Gold, silver have lustre.

→ Electrical and thermal conductivity → Due to free electrons metals are good conducter of heat and electricity.
Silver is best conducter of heat and electricity.
• Lead and mercury are comparatively poor conductor of heat.

→ Melting point → Generally all metals have high melting & boiling point. Tungsten has the heighest melting point among metals.
Except → mercury, Caesium, Gallium are melt if we keep them on our palm.

Alkali metals ⇨ (lithium, sodium, potassium) are soft they can be cut with a knife.
They have also low densites and low melting point.

▷ NON METALS ⇨ Those elements which form negative ions by gaining electrons are called non-metals.

→ Hardness ⇨ Generally all non-metals are soft.
except → Diamond.

→ Malleability & Ductility ⇨ Non-metals neither malleable nor ductile, However diamond (allatroph of carbon) is hard but not convert into wire or sheet.

→ Brittliness - Non-metals are brittle in nature.
for instance, sulphur is a brittle in nature, if it is hammered, it breaks into piece.
Except → Diamond.

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- Lustre ⇨ Non-metals are non lustrous. Except - Iodine, Although graphite is dark black in color but has shiny surface.

- Electricity & thermal conductivity ⇨ They are poor conductor of Electricity & heat. Except graphite is good conductor of electricity & Diamond is the good conductor of heat.

- Melting & Boiling point ⇨ melting and boiling points are law of non metals. Except - Boron, Silicon, carbon

Nitrous oxide
Nitric oxide
carbon monoxide
→ are some neutral oxides

CHEMICAL PROPERTIES OF METALS

(i) Reaction of metal with oxygen
- allmost all metals combined with oxygen to form metal oxide. METAL + OXYGEN ⟶ METALOXIDE

Example - $2Cu + O_2 \xrightarrow{\Delta} 2CuO$

★ Some metals oxides such as Alluminium oxide, Zinc oxide show both types of behaviour i.e. Acidic & Basic such metal oxide react with both acid & Base to produce salt and water are known as Amphateric oxides.

$Al_2O_3 + HCl \longrightarrow AlCl_3 + H_2O$

$$Al_2O_3 + NaOH \longrightarrow NaAlO_2 + H_2O$$
(Sodium Aluminate)

- Metal react with water and produce a metal oxide and hydrogen gas metal oxide further react with water to form metalic base. all metals do not react with water as the metals placed lower in reactivity series are less reactive towards ~~with~~ water.

Metal + water → metal oxide + H_2

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

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2 + Heat$$

The heat envolved is sufficient for Hydrogen to catch fire, that's why Na & K catch fire when Kept in water. So, for prevention these metals are Kept in Kerosene oil in order to avoid contact with both air & water.

The reaction of calcium with cold water is less reactive as Na & K. The heat envolved is not sufficient for the hydrogen to catch fire.

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

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☆ Metals like Mg react with hot water and form magnesium hydroxide and form H_2 gas magnesium floats over water because the bubbles of hydrogen gas and stick on the surface of metal.

$$2Mg + 2H_2O \longrightarrow 2MgO + H_2$$

☆ Metals like Al, Zn and Fe do not react with hot and cold water, they react with steam and form the metal oxide and hydrogen.

$$2Al_{(s)} + 3H_2O \longrightarrow Al_2O_{3(s)} + 3H_2$$

☆ Lead, Copper, silver and gold do not react with water at all.

Reaction of metal with acid.

Reaction of Metal with dilute HCl and sulphuric ~~aic~~ acid. Except of few less reactive metals such as (Cu, Hg, Ag, Au, PT) all metal react with dilute sulphuric acid and HCl to produce salt and Hydrogen gas.

Metal + Dilute acid $\longrightarrow$ Salt + $H_2\uparrow$

$Zn + HCl \longrightarrow ZnCl_2 + H_2$

due to its electropositive nature it has been placed in the reactivity series.

FLAME TEXT —

Sodium $\longrightarrow$ Yellowish flame

★ Reaction of metal with dilute HNO_3, Hydrogen gas is not evolved when a metal react with Nitric acid this is due to strong oxidising nature of nitric acid.
It oxidises the H_2 produce to water and itself get reduced to any of Nitrogen oxide. (NO_2, N_2O, NO)

Exception - Magnesium (Mg) and magnese (Mn) reacts with dilute HNO_3 to envolved H_2 gas.

$$Mg + 2HNO_3 \longrightarrow Mg(NO_3)_2 + H_2\uparrow$$

Reaction of metal with other metal salts.

Reactive metal can displace comparatively less reactive metal form its compound in aques salt solution or in molten state.

metal A + Salt Solution of B → Salt Solution of A + metal B.

$Na + CuCl_2 \rightarrow NaCl + Cu$

$KCl + Fe \rightarrow$ No reaction, because K is more reactive than Fe.

★ Lithium metal is not Kept in Kerosene oil even it is very reactive, because it floats on the Kerosene, so parafin wax are used to store it.

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NOTE Hydrogen also have non-metalic property but due to its electropositive nature it has been placed in the reactivity series.

FLAME TEXT —

Sodium	→	Yellowis flame
Potassium	→	Purple flame
Calcium	→	Orange flame
Iron	→	Yellowis flame
Cu	→	Green
Magnesium	→	White
Nitrogen	→	Brown

Chemical properties of Non-metals

- Chemical properties of non-metal is due to their electronegative nature i.e tendency to Gain electrons in their outermost cell to achieve the configuration of nearest nobel gas elements.

Reaction with WATER.

NON-METALS do not react with water.

Displacement Reaction —

NON-METALS ALSO SHOW DISPLACEMENT REACTION LIKE METAL.

$$Cl_2 + 2NaBr \longrightarrow 2NaCl + Br_2$$

★ Reactivity series of non-metals F > O > N > Cl > Br > I.

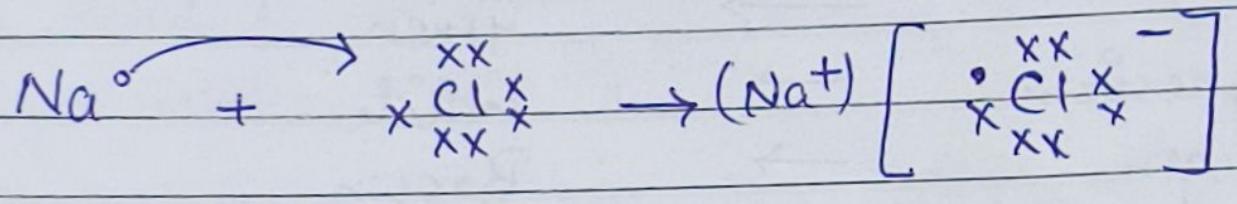
Reaction b/w METALS and NON-METALS

$Na \longrightarrow Na^+ + e^-$

2, 8, 1 — 2, 8 (sodium cation)

$Cl + e^- \longrightarrow Cl^-$

2, 8, 7 — 2, 8, 8 (chloride anion)



Sodium and chloride ions, being oppositely charged attract each other and are held by strong electrostatic forces of attraction to exist as sodium chloride (NaCl). Sodium chloride does not exist as molecules but aggregates of oppositely charged ions.

◻ Ionic or electrovalent compound.

A chemical compound formed by the complete transfer of electrons from one atom to another atom, such compound are ionic or electrovalent compound.

It is of 2 type -

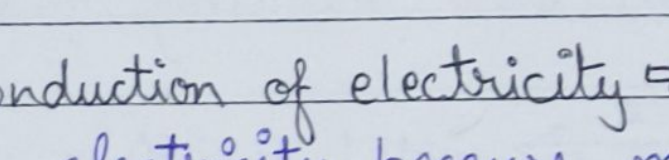
→ Cation (+) → Anion (−)

Cation (+) ⇨ A metal gives electrons to form cation.

Anion (−) ⇨ A non-metal gain electrons to form anion.

$Mg \longrightarrow Mg^{+} + 2e^{-}$ | $Cl + 2e^{-} \rightarrow Cl^{-}$

2,8,2 → 2,8 | 2,8,7 → 2,8,8



⇨ $Mg^{2+} 2Cl^{-}$

Properties of Ionic compound.

▷ Physical Nature ⇨ Generally they are crystalline solid because of force of Attraction between the positive and negative ions and they are generally brittle.

▷ Melting and Boiling Point ⇨ Ionic compounds have high melting & Boiling point. So, large amount of energy is required to break the strong into ionic compound.

▷ Solubility ⇨ Electrovalent compounds are generally soluble in water and insoluble in solvent such as Kerosene, Petrol, Benzene etc.

▷ Conduction of electricity ⇨ In the solid state there no flow of electricity because movement of ions is not possible in solid. But in the aques and molten state thore are best conducter of electricity because solution of ionic

compound in water contain free electron when electricity is passed through it.

Metallurgy — The process of extracting metals from their ore and converting impure metals into pure metals.

◆ Enrichment of Ores.

The ore are mined from the earth crust contains some unwanted impurities such as Sand, Clay, rocks particularly these substances are called Gangue.

- The process of removing gangue from the ore is called Enrichment of Ore.

∴ Extraction of metals of low Reactivity -

(i) Cinnabar HgS — is an ore of Mercury.

When HgS heated in air, it first changes into its oxide and then into mercury metal.

$$2HgS(s) + 3O_2(g) \xrightarrow{\Delta} 2HgO + 2SO_2(g)$$

$$2HgO(s) \xrightarrow{\Delta} 2Hg + O_2$$

(iii) Copper galance — Cu_2S when it is heated in air partialy oxidised and the oxidind product react with remaining copper glance to give copper metal.

$$2Cu_2S + 2O_2 \xrightarrow{\Delta} 2Cu_2O + 2SO_2$$

$$2Cu_2O + Cu_2S \xrightarrow{\Delta} 6Cu + SO_2$$

÷ Extraction of metal of medium reactive metal series such as Iron, Zinc, lead and copper are moderate reactive.

These metals are usually present as sulphide or carbonate in nature these ore firstly converted into oxide because, it is easy to extract metals from its oxide than ore.

Sulphide ore converted into oxides by Roasting and carbonate into oxides by calcination.

Roasting ⇨ It is a process in which ore is heated strongly in the presence of excess amount of air and below its melting point.

Example

$$2ZnS_{(s)} + 3O_{2(g)} \xrightarrow{\Delta} 2ZnO_{(s)} + 2SO_{2(g)}$$

$$2PbS_{(s)} + 3O_{2(g)} \xrightarrow{\Delta} 2PbO_{(s)} + 2SO_{2(g)}.$$

Calcination → It is a process in which ore is heated strongly in the presence of limited air. this process is for carbonate ore.

Example

$$CaCO_{3(s)} \xrightarrow{\Delta} CaO_{(s)} + CO_{2(g)}$$
$$ZnCO_{3(s)} \xrightarrow{\Delta} ZnO_{(s)} + CO_{2(g)}$$
$$FeCO_{3(s)} \xrightarrow{\Delta} Fe_2O_{3(s)} + CO_{2(g)}$$

Chemically Reduction -

$$ZnO_{(s)} + C_{(s)} \longrightarrow Zn_{(s)} + CO_{2(g)}$$

Besides using carbon (coke) to reduce metal oxide to metals sometimes displacement reactions can be used. The highly reactive metals such as sodium, aluminium, calcium etc are used as reducing agent.

$$3MnO_2 + 4Al \longrightarrow 3Mn_{(l)} + 2Al_2O_3 + Heat$$

★ The displacement reactions are highly exothermic. The amount of heat envalved is so large that the metals are produced in molten state.

The reaction of Iron III oxide (Fe_2O_3) with Al is used to join railway track, or cracked machine parts.
This reaction is Known as thermit reaction.

÷ Extraction of metal of Highly Reactive.

- This method is used for K, Na, Mg, Ca, Al, etc

- They can't be obtained from this compound by heating with carbon. This is because these metals have more affinity for oxygen than carbon. These metals are obtained by Electrolytic reduction.

Metal is deposited at cathode and Cl is deposited at anode.

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

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

◆ Electrolytic Refining ...

Many metals like Cu, Sn, Ni, Ag etc are refining electrolytically.

Process → In this process a thick strip of impure metal is used as anode and a thin strip of pure metal is used as cathode. A solution of metal salt (to be refined) is used as an electrolyte when electric current is passed in solution metal ions from the anode dissolve in electrolyte and pure metal from electrolyte is deposited on the cathod, the soluble impurities goes into the solution. However the insoluble impurities settle down at the bottom of the anode and are known as anode mud.

Corrosion —

The surface of some metals, such as iron is corrode when they exposed to moist air for a long period of time. This phenomena is called Corrosion.

- Silver articles become black after some time exposed in air. This is because silver react with sulphur in air and form coating of silver sulphide.
- Copper react with moist carbon dioxide in air and losses its shiny brown surface and gains green coat of basic copper carbonate.

Prevention of Corrosion -

The rusting of iron can be preventing by Painting, greasing, oiling, galvanisation, Chrome planting, Anodising & making alloys.

Galvanisation

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

Anodising → During anodising, a clean aluminium article work as an anode & is electrolyzed dilute sulphuric acid (H_2SO_4). The oxygen gas envolved at the anode react with Al to make a thicker protective layer of oxide. This oxide layer can be dyed easily to give aluminium articles an attractive finish.

• Alloying

An Alloy is a homogenous mixture of two or more metal, or a metal and a non-metal. It is prepared by first melting the primary metal and then dissolving the other metal or element in it in definite proportions. It is then cooled to room temperature.