General properties Transition Metals

- The transition metals lie between groups 2A and 3A of the periodic table.
- They are malleable and ductile
- They are good conductors of heat and electricity
- Transition metals are less reactive but melting and boiling points are higher than 1A and 2A group elements

I R O N

- Its density is 7.87 g/cm^3
- Melting point is 1538 ºC
- Boiling point is 2861 ºC

- Pure iron is a silvery white colored, lustrous, soft metal with important magnetic properties. It is malleable and ductile.

Occurrence of iron

- Iron is second most abundant metal (6%) in the earth's crust. But it is not found in elemental form in nature.
- Iron is found in most clays, sandstones and granites.
- Hematite Fe_2O_3 Pyrite FeS_2
- Magnetite Fe_3O_4 Siderite $FeCO_3$

  are common ores of iron

Preparation of Iron

In the laboratory

1. H_2 gas is added to iron oxide

   $Fe_2O_3 + 3H_2 \longrightarrow 2Fe + 3H_2O$

2. Iron oxides are reduced by more active metals

   $3FeO + 2Al \longrightarrow 3Fe + Al_2O_3$

   $Fe_2O_3 + 2Al \longrightarrow 2Fe + Al_2O_3$

3. By the electrolysis of solutions of iron salts

   $FeCl_2 \longrightarrow Fe + Cl_2$

Chemical Properties of Iron

- Iron has $_{26}Fe$: $[_{18}Ar]4s^2 3d^6$ electron configuration
- In compounds, iron takes +2 and +3 0xidation states (charges)

Reactions of Iron

1) Iron reacts with dilute solutions of strong acids.

$Fe + 2HCl \rightarrow FeCl_2 + H_2$

$Fe(s) + H_2SO_4(dil.) \rightarrow FeSO_4(aq) + H_2(g)$

- The reactions of iron with oxidizing acids form its salts, containing Fe3+ ions

$2Fe(s) + 6H_2SO_4(conc) \rightarrow Fe_2(SO_4)_3(aq) + 3SO_2 + 6H_2O$

$Fe(s) + 4HNO_3(dil.) \rightarrow Fe(NO_3)_3(aq) + NO(g) + 2H_2O(l)$

2) Iron produces mixed oxides by water

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

3) When iron is heated with sulfur iron sulfide, FeS forms

$$Fe(s) + S(s) \xrightarrow{t} FeS(s)$$

4) At high temperature, it reacts with halogens.

$$2Fe(s) + 3Cl_2(g) \xrightarrow{1200°C} 2FeCl_3(s)$$

- Moisture and oxygen cause the formation of crystal hydrate of iron (III) oxide (corrosion)

$$4\ Fe + 3\ O_2 + nH_2O \rightarrow \underset{\text{red-brown}}{2Fe_2O_3 \cdot nH_2O}$$

- **Uses**

Iron is useful in our society today because iron is virtually used in everything : building (bridge , highway , rail road ,etc.), transportation (car , train , boats ,plane, etc.) , tools (knife , machines , etc.)

IMPORTANT COMPOUNDS OF IRON

- Iron has +2 and +3 oxidation states in its compounds. Fe^{2+} ion is called ferrous and compounds that contain Fe^{2+} ion are called ferrous compounds,
- Fe^{3+} ion is called ferric and Fe^{3+} compounds are called ferric compounds

Iron (II) compounds (Ferro Compounds)

- **1. Iron (II) chloride, $FeCl_2$**
- It is obtained by passing hydrogen chloride gas over heated iron. $FeCl_2$ is a white colored crystal.
- $Fe\ (s) + 2HCl\ (g) \rightarrow FeCl_2\ (s) + H_2\ (g)$

- **2. Iron (II) oxide, FeO**
- This compound is produced by decomposition of iron (II) oxalate.

$$FeC_2O_4\,(s) \xrightarrow{heat} FeO\,(s) + CO\,(g) + CO_2(g)$$

- FeO is also unstable in air.

$$4FeO\,(s) + O_2\,(g) \rightarrow 2Fe_2O_3\,(s)$$

Iron (III) Compounds (Ferric Compounds)

- **1. Iron(III) chloride, $FeCl_3$**
- When iron is reacted with chlorine gas, it produces iron(III) chloride.

$$2Fe(s) + 3Cl_2(g) \xrightarrow{heat} 2FeCl_3(s)$$

- **2. Iron (III) hydroxide, $Fe(OH)_3$**
- It is obtained by the reaction of Fe^{3+} with a base or carbonates. It is similar to gelatin. $Fe(OH)_3$ is a reddish-brown colored precipitate which shows amphoteric property.
- $Fe^{3+}(aq) + 3KOH(aq) \rightarrow Fe(OH)_3(s) + 3K^{+}(aq)$

3. Iron (III) oxide, Fe2O3

In nature Fe_2O_3 is found in hematite and limonite minerals. It can be obtained by several methods.

- $2FeCl3 + 3H_2O \xrightarrow{heat} Fe_2O_3 + 6HCl$
- $4FeO + O_2 \rightarrow 2Fe_2O_3$
- $2Fe(OH)_3 \rightarrow Fe_2O_3 + 3H_2O$
- $4Fe(OH)_2 + O2 \rightarrow 2Fe_2O_3 + 4H_2O$

The most common preparation method of Fe_2O_3 is the burning of pyrite, FeS_2 mineral.

- $4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$

- **Iron(II, III) oxide, Fe3O4**
- Fe_3O_4, mixed oxide, is obtained by passing heated steam over iron metal or heating Fe_2O_3
- $3Fe + 4H_2O \xrightarrow{heat} Fe_3O_4 + 4H_2$

- $6Fe_2O_3 \xrightarrow{heat} 4Fe_3O_4 + O_2$
- Fe_3O_4 is found in nature as black colored magnetite.

Compounds of Iron

- Ferro Compounds; Iron(II) compounds
  1. Iron (II) chloride, $FeCl_2$
  2. Iron (II) sulfate ; $FeSO_4 \cdot 7H_2O$
  3. Iron (II) oxide; FeO
- Ferric Compounds; Iron (III) compounds
  1. Iron (III) chloride; $FeCl_3$
  2. Iron (III) oxide; Fe_2O_3
  3. Iron (III) hydroxide $Fe(OH)_3$
- Iron (II, III) oxide, Fe_3O_4