

# 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

# IRON

- Its density is  $7.87 \text{ g/cm}^3$
- Melting point is  $1538 \text{ }^\circ\text{C}$
- Boiling point is  $2861 \text{ }^\circ\text{C}$
  
- Pure iron is a silvery white colored, lustrous, soft metal with important magnetic properties. It is malleable and ductile.

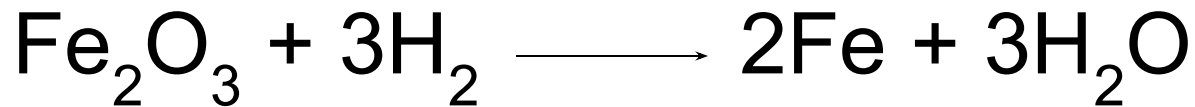
# Occurrence of iron

- 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  $\text{Fe}_2\text{O}_3$       Pyrite  $\text{FeS}_2$
- Magnetite  $\text{Fe}_3\text{O}_4$       Siderite  $\text{FeCO}_3$   
are common ores of iron

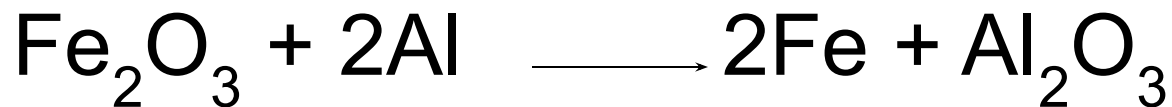
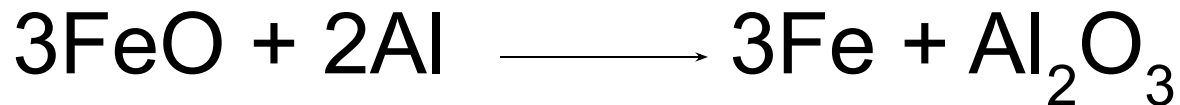
# Preparation of Iron

## In the laboratory

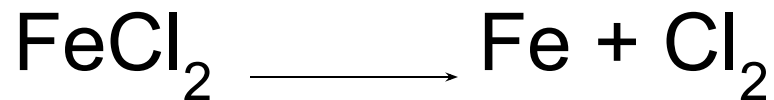
1. H<sub>2</sub> gas is added to iron oxide



2. Iron oxides are reduced by more active metals



3. By the electrolysis of solutions of iron salts

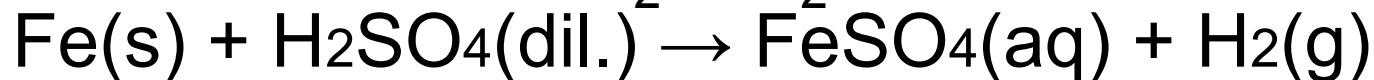
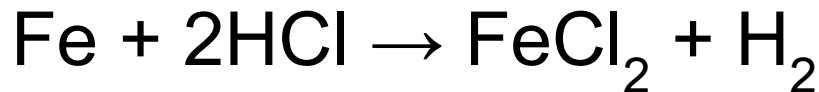


# Chemical Properties of Iron

- Iron has  ${}_{26}\text{Fe}$ :  $[{}_{18}\text{Ar}]4s^23d^6$  electron configuration
- In compounds, iron takes +2 and +3 Oxidation states (charges)

# Reactions of Iron

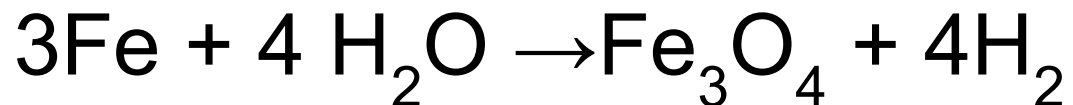
1) Iron reacts with dilute solutions of strong acids.



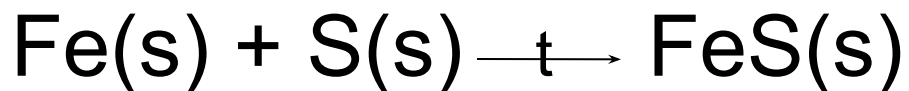
- The reactions of iron with oxidizing acids form its salts, containing Fe<sup>3+</sup> ions



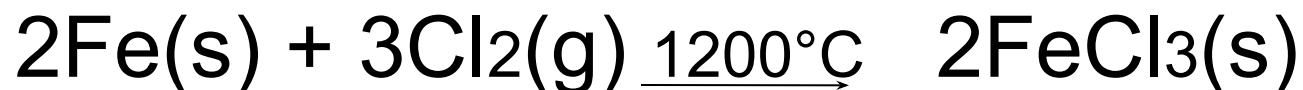
2) Iron produces mixed oxides by water



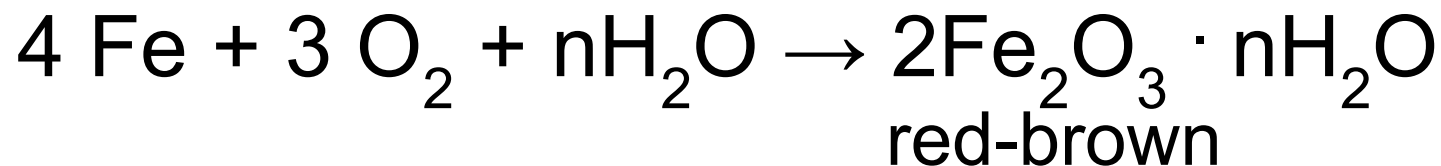
3) When iron is heated with sulfur iron sulfide, FeS forms



4) At high temperature, it reacts with halogens.



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





- **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

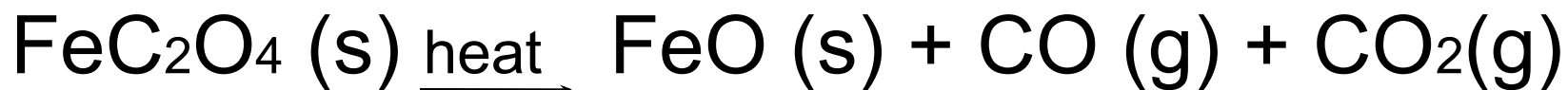
- Iron has +2 and +3 oxidation states in its compounds.  $\text{Fe}^{2+}$  ion is called ferrous and compounds that contain  $\text{Fe}^{2+}$  ion are called ferrous compounds,
- $\text{Fe}^{3+}$  ion is called ferric and  $\text{Fe}^{3+}$  compounds are called ferric compounds

# Iron (II) compounds (Ferro Compounds)

- **1. Iron (II) chloride, FeCl<sub>2</sub>**
- It is obtained by passing hydrogen chloride gas over heated iron. FeCl<sub>2</sub> is a white colored crystal.
- $\text{Fe (s)} + 2\text{HCl (g)} \rightarrow \text{FeCl}_2 \text{ (s)} + \text{H}_2 \text{ (g)}$

- **2. Iron (II) oxide, FeO**

- This compound is produced by decomposition of iron (II) oxalate.

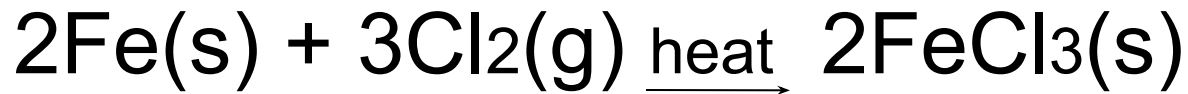


- FeO is also unstable in air.



# Iron (III) Compounds (Ferric Compounds)

- **1. Iron(III) chloride, FeCl<sub>3</sub>**
- When iron is reacted with chlorine gas, it produces iron(III) chloride.



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

### 3. Iron (III) oxide, Fe<sub>2</sub>O<sub>3</sub>

In nature Fe<sub>2</sub>O<sub>3</sub> is found in hematite and limonite minerals.

It can be obtained by several methods.

- $2\text{FeCl}_3 + 3\text{H}_2\text{O} \xrightarrow{\text{heat}} \text{Fe}_2\text{O}_3 + 6\text{HCl}$
- $4\text{FeO} + \text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$
- $2\text{Fe}(\text{OH})_3 \rightarrow \text{Fe}_2\text{O}_3 + 3\text{H}_2\text{O}$
- $4\text{Fe}(\text{OH})_2 + \text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3 + 4\text{H}_2\text{O}$

The most common preparation method of Fe<sub>2</sub>O<sub>3</sub> is the burning of pyrite, FeS<sub>2</sub> mineral.

- $4\text{FeS}_2 + 11\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3 + 8\text{SO}_2$

- **Iron(II, III) oxide, Fe<sub>3</sub>O<sub>4</sub>**
- Fe<sub>3</sub>O<sub>4</sub>, mixed oxide, is obtained by passing heated steam over iron metal or heating Fe<sub>2</sub>O<sub>3</sub>
- $3\text{Fe} + 4\text{H}_2\text{O} \xrightarrow{\text{heat}} \text{Fe}_3\text{O}_4 + 4\text{H}_2$
- $6\text{Fe}_2\text{O}_3 \xrightarrow{\text{heat}} 4\text{Fe}_3\text{O}_4 + \text{O}_2$
- Fe<sub>3</sub>O<sub>4</sub> is found in nature as black colored magnetite.



# Compounds of Iron

- Ferro Compounds; Iron(II) compounds
  1. Iron (II) chloride,  $\text{FeCl}_2$
  2. Iron (II) sulfate ;  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$
  3. Iron (II) oxide;  $\text{FeO}$
- Ferric Compounds; Iron (III) compounds
  1. Iron (III) chloride;  $\text{FeCl}_3$
  2. Iron (III) oxide;  $\text{Fe}_2\text{O}_3$
  3. Iron (III) hydroxide  $\text{Fe}(\text{OH})_3$
- Iron (II, III) oxide,  $\text{Fe}_3\text{O}_4$