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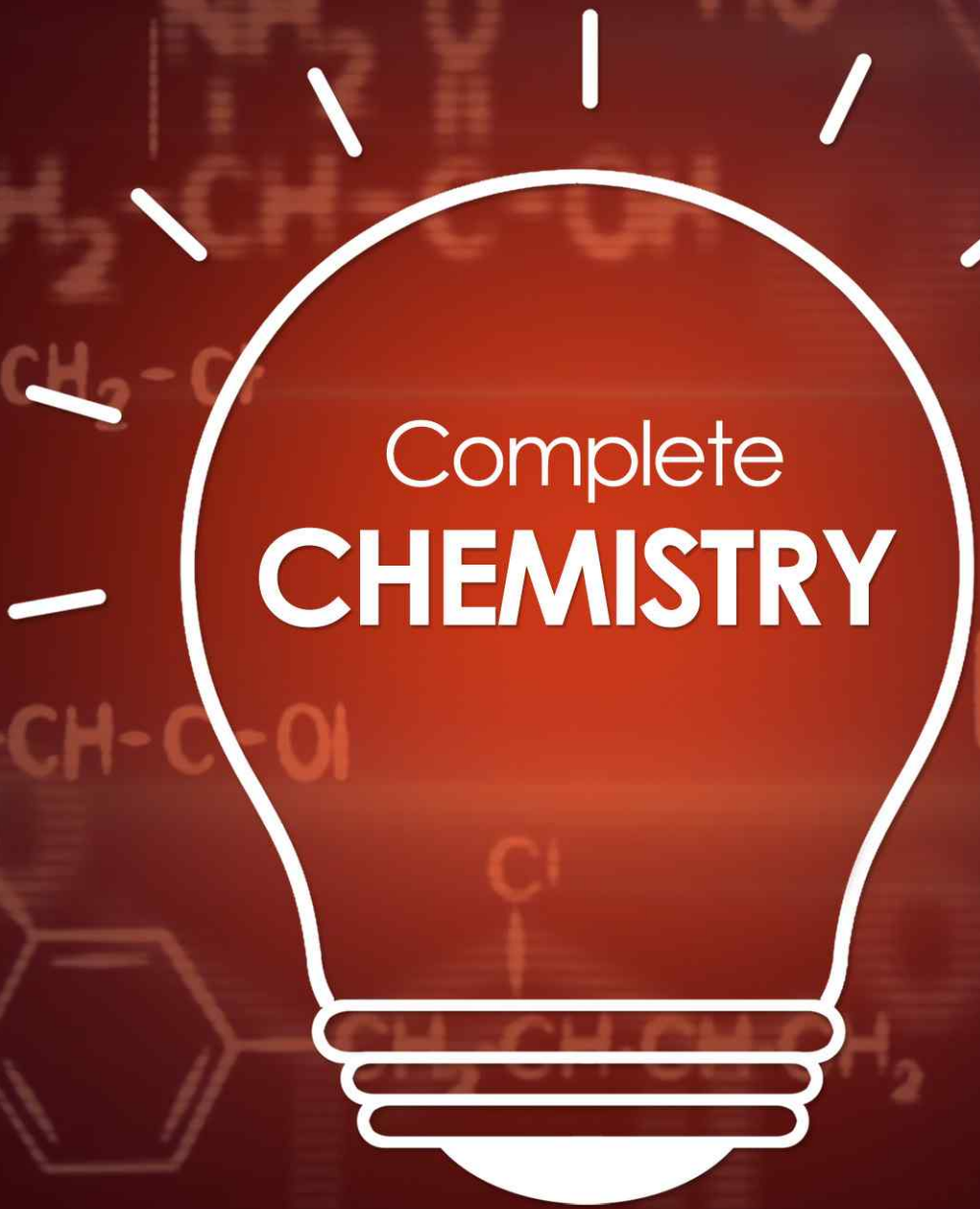


Complete CHEMISTRY

IIT-JEE · NEET · CBSE eBOOKS

CLASS 11&12th

CLASS 12th

General Principles & Isolation of Elements

01. Introduction

(i) **Minerals :** Naturally occurring solid substances having metals in combined state or native state are called minerals. Minerals do not contain NO_3^- ion because all nitrate salts are water soluble.

(ii) **Ore :** A mineral is an ore from which one or more metals can be extracted easily and profitably.

(iii) **Matrix or Gangue :** Minerals are always associated with earthy impurities known as matrix or gangue.

(iv) **Flux :** It is a substance used to decrease the melting point of an ore or a substance used to react with impurities to form slag.

(a) **Acidic flux :** It converts basic impurities to slag. For example, SiO_2 is used in the metallurgy of copper to remove FeO as $FeSiO_3$(slag).
Other acidic fluxs are → B_2O_3, P_4O_{10} etc. $FeO + SiO_2 \rightarrow FeSiO_3$

(b) **Basic flux :** It converts acidic impurities to slag. For example, CaO is used in the metallurgy of iron to remove SiO_2 as $CaSiO_3$ (slag).
Other basic fluxs are → $CaCO_3$, $MgCO_3$, MgO etc. $SiO_2 + CaO \rightarrow CaSiO_3$

(v) **Slag :** The low fusible substance produced by the reaction of flux with impurities during extraction of metals, is called slag. The process is called slagging operation.

(vi) **Alloy :** It is a homogeneous mixture of a metal with one or more elements that may be metals or non-metals.

(vii) **Metallurgy :** The complete scientific and technological process employed for the extraction of a metal from its ore is called metallurgy.

02. Occurrence of Metals

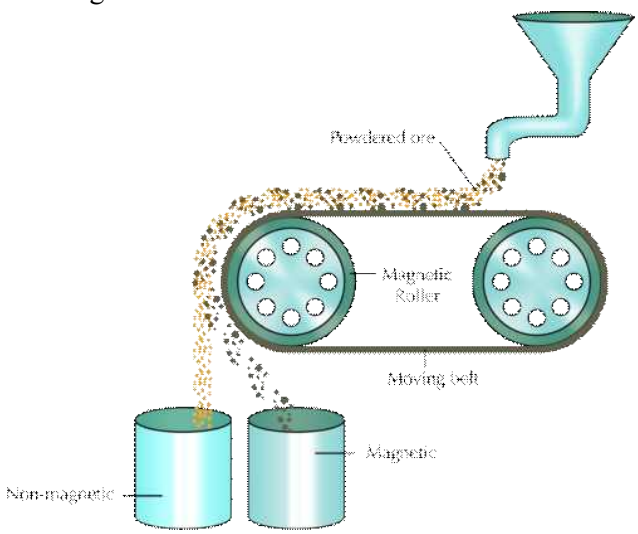
Metal	Mineral	Average composition
Iron	Haematite	Fe_2O_3
	Magnetite	Fe_2O_4
	Iron pyrites	FeS_2
	Siderite	$FeCO_3$
	Chromite	$FeO.Cr_2O_3$
Copper	Chalcopyrites or copper pyrites (Fool's gold)	$CuFeS_2$[Actual form : $Cu_2S.Fe_2S_3$]
	Copper glance	Cu_2S
	Cuprite	Cu_2O
	Malachite	$CuCO_3.Cu(OH)_2$
	Azurite	$2CuCO_3.Cu(OH)_2$
Aluminium	Bauxite	$AlO_x(OH)_{3-2x}[0 < x < 1]$ major form is $Al_2O_3.2H_2O$
	Cryolite	Na_3AlF_6
	Kaolinite (a clay)	$[Al_2(OH)_4.Si_2O_5]$
	China clay	$Al_2O_3.SiO_2.2H_2O$

Metal	Mineral	Average composition
Zinc	Sphalerite or Zinc Blende Zincite Smithsonite or Calamine	ZnS ZnO $ZnCO_3$
Silver	Argentite or Silver galnce Horn silver	Ag_2S AgSl

03. Extraction of Metals and Non-metals (General)

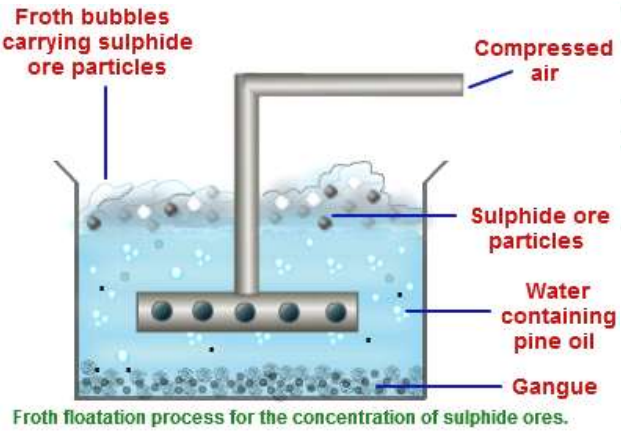
(i) **Pulverisation :** The lumps of ore are converted to small pieces by using jaw crushers and to powder by employing stamp mill or ball mill.

(ii) **Magnetic separation :** This method is employed to separate the magnetic and non-magnetic components present in the ore by carrying the powdered ore on a conveyer belt passing over an electromagnetic roller.



(iii) **Hydraulic washing :** This method is employed to purify heavier ore such as oxides (e.g., haematite, tin stone etc.), carbonates (e.g., calamine, malachite, etc), native gold, etc.

(iv) **Froth floatation process :** This method is employed to purify/concentrate sulphide ores.



Froth floatation process for the concentration of sulphide ores.

(v) **Leaching :** $Al_2O_3.2H_2O + 2NaOH \xrightarrow[200\text{-}250^\circ C]{45\%NaOH} 2NaAlO_2 + 3H_2O$

$$NaAlO_2 + H_2O \xrightarrow[\approx 36hrs/25\text{-}30^\circ C]{Al(OH)_3} Al(OH)_3 + NaOH$$

$$2Al(OH)_3 + H_2O \xrightarrow{1200^\circ C} Al_2O_3 + 3H_2O$$

(vi) **Conversion of Ore to Oxide Form :**

(a) **Calcination :** Conversion of hydrated oxides, carbonates, basic carbonates and hydroxide ores to their oxides by heating in the absence of O_2 below their melting point is known as calcination.

$$ZnCO_3(s) \xrightarrow{\Delta} ZnO(s) + CO_2 \uparrow$$

(b) **Roasting :** Sulphide ores are generally roasted in reverberatory furnace in free supply of air below melting point.

$$2ZnS + 3O_2 \xrightarrow{\Delta} 2ZnO + 2SO_2$$

(vii) **Reduction of oxide to metal :**

(a) **Smelting : Carbon reduction method**

$$ZnO + C \xrightarrow{\approx 1400^\circ C} CO + Zn$$

(b) **Reduction by H_2**

$$WO_3 + 3H_2 \longrightarrow W + 3H_2O$$

(c) **Metals as reducing agents**

$$TiCl_4 + 2Mg \longrightarrow 2MgCl_2 + Ti$$

(d) **Auto reduction or self reduction or air reduction method**

$$Cu_2S \xrightarrow[-SO_2]{O_2/\Delta} Cu_2O \xrightarrow{Cu_2S/\Delta} Cu + SO_2$$

04. Ellingham Diagrams