# CONCEPT MAP

## GENERAL PRINCIPLES AND PROCESSES OF ISOLATION OF ELEMENTS

**ELEMENTS**

**Mode of Occurrence**

### Native State

Elements with very low reactivity occur in free state. *e.g.* C, S, N, Noble gases, metals like Ag, Au, Pt, etc.

### Combined State

Elements which are very reactive occur in the form of their compounds called **Minerals** (metals → in oxidised form, non-metals in reduced form). The minerals from which metals can be conveniently and economically extracted → **ORES**

### Extraction – Metallurgy

The impurities present → gangue or matrix.

#### Crushing and Grinding (Pulverisation)

Lumps of ore $\xrightarrow{\text{Crushers}}$ small pieces $\xrightarrow{\text{ball mill}}$ Fine powder

#### Concentration or Benefication of Ore

- **Hand picking**
- **Gravity separation or levigation, hydraulic washing :** For oxide ores, based on difference in densities of ore (heavier) and gangue particles (lighter). *e.g.* haematite, etc.
- **Froth-floatation :** For sulphide ores, based on perferential wetting of ore (by oil) and gangue (by water).
- **Magnetic separation :** Based on difference in magnetic properties.
- **Chemical method - leaching :** When ore is soluble in a suitable solvents.
  For Al → **Baeyer's process :** from bauxite.
  For Au → **Mac Arthur Forest Cyanide** process.

#### Conversion to Oxide form

- **Calcination :** Carbonates and hydrated oxide ores heated strongly in a limited supply of air or in the absence of air.
- **Roasting :** Sulphide ores strongly heated in excess of air. Both carried out in reverberatory furnance.

#### Conversion of oxide to metal – Reduction

- **By carbon :** Smelting
- **By heating** with a suitable reducing agent → Thermal reduction or pyrometallurgy.
  Flux + Gangue → Slag.
- **Reduction by Al** → alumino-thermy or Gold schmidt thermite process.
- **Autoreduction :** For reduction of sulphide ores of Pb, Hg and Cu. No reducing agent used.
- **Electrometallurgy :** Electrolysis for highly electropositive metals (like group 1 and 2 elements) *e.g.* Na
- **Reduction by precipitation :** Hydro-metallurgy or displacement method.

#### Purification or Refining of Metals

Metal obtained from Step IV is impure → crude → purified by refining.

- **Distillation :** For low boiling metals. *e.g.* Zn, Hg, Cd, etc.
- **Liquation :** For metals with low melting points. *e.g.* Sn, Pb, Bi, etc.
- **Electrolytic refining :** Impure metal → anode, pure metal → cathode, soluble salt of metal → electrolytic solution, on passing electricity → insoluble impurities settle down below anode → anode mud.
- **Zone refining :** For very high purity metals, *e.g.* Si, Ge, B, Ga, In, As, etc. based on principle of fractional crystallization *i.e.* difference in solubilities of impurities molten and solid state of metal.
- **Van Arkel method** – Vapour phase refining: For ultrapure metals. *e.g.* Ti, Zr, Th, U, etc.
- **Chromatography :** To separate different component of a mixture
- **Poling :** When impurities of own metal present. *e.g.* Cu, O in blister Cu.
- **Cupellation :** When impurities of other metals present form volatile oxides. *e.g.* Pb traces in Ag.