

NEET/JEE 2019

Focus more to get high rank in NEET, JEE (Main and Advanced) by reading this column. This specially designed column is updated year after year by a panel of highly qualified teaching experts well-tuned to the requirements of these Entrance Tests.

UNIT - 3 : General Principles and Processes of Isolation of Elements | The *p*-Block Elements (Group 15 to 18)

GENERAL PRINCIPLES AND PROCESSES OF ISOLATION OF ELEMENTS

OCCURRENCE OF METALS

Metals generally occur in combined or native states in the earth's crust. Some of their salts are found in sea water.

- **Minerals:** The combined state in which the metals occur in the earth's crust are known as minerals.
- **Ores:** Minerals from which the metals can be extracted conveniently and profitably. All ores are minerals but all minerals are not ores.
- The unwanted earthy impurities associated with ore is known as gangue or matrix.

Some Important Ores of Metals

| Metal | Ore |
|-----------|---|
| Magnesium | Carnallite, $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ |
| Aluminium | Bauxite, $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$ |
| Iron | Haematite, Fe_2O_3 ; Magnetite, Fe_3O_4 |
| Copper | Copper pyrites, CuFeS_2 Cuprite, Cu_2O |
| Tin | Cassiterite, SnO_2 |
| Lead | Galena, PbS |
| Silver | Argentite, Ag_2S ; Native Silver |

METALLURGY

The whole process of extracting metals from their ores is called metallurgy. Metallurgy of a metal involves three main steps :

- Concentration or dressing of the ore
- Extraction and isolation of metal
- Purification or refining.

Concentration or Dressing of the Ore

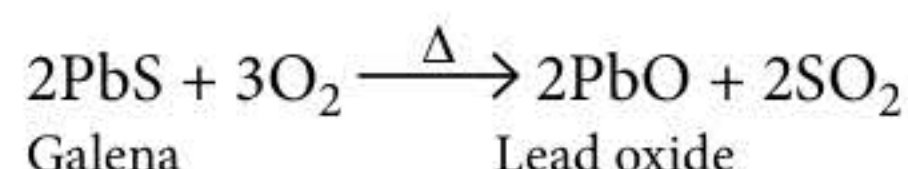
To remove undesirable impurities, different methods are used for the concentration of ores.

- **Hand picking :** When impurities are of large size.
- **Froth floatation process :** Used for concentration of sulphide ore and based on preferential wetting of ore by oil.
- **Electromagnetic separation :** When either ore or impurities are magnetic in nature.
- **Leaching process :** Ore is treated with suitable reagent that preferentially dissolves the ore particle while impurities remain insoluble.
- **Gravity separation :** Used when ore particles are heavier than impurities.

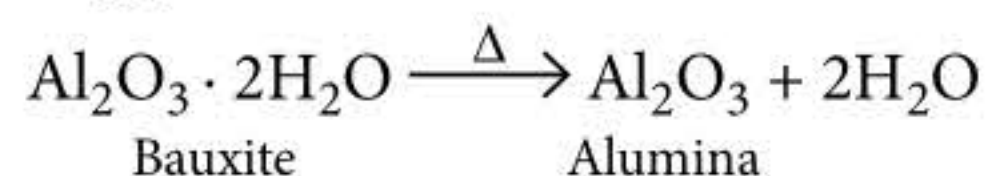
Extraction and Isolation of Metal

Conversion of ore into metal oxide

- **Roasting** : The concentrated ore (usually sulphide) is heated strongly, in the presence or excess of air below its melting point.



- **Calcination** : The process of converting concentrated ore into oxide by, heating it strongly below its melting point in the absence of air.



Reduction of metal oxide to free metal

- **Smelting** : Extraction of metal from its oxide by reduction with carbon (coal or coke). *e.g.*,
 $\text{PbO} + \text{C} \longrightarrow \text{Pb} + \text{CO}$
- **Pyrometallurgy** : Extraction of metal by heating the metal oxide with a suitable reducing agent.
- **Goldschmidt aluminothermite process** : It is done by using aluminium. *e.g.*,
 $3\text{Mn}_3\text{O}_4 + 8\text{Al} \longrightarrow 9\text{Mn} + 4\text{Al}_2\text{O}_3$
- **Self-reduction process** : This process is also called auto reduction process. The sulphide ores of less electropositive metals like Hg, Pb, Cu, etc., are heated in air. No external reducing agent is used in this process. *e.g.*, extraction of Hg from cinnabar ore
 $2\text{HgS} + 3\text{O}_2 \longrightarrow 2\text{HgO} + 2\text{SO}_2$
 $2\text{HgO} + \text{HgS} \longrightarrow 3\text{Hg} + \text{SO}_2$
- **Electrolytic reduction** : The highly electropositive metals like Na, K, Mg, Ca, Al, etc. are extracted by the electrolysis of their oxides, hydroxides or chlorides in fused state.

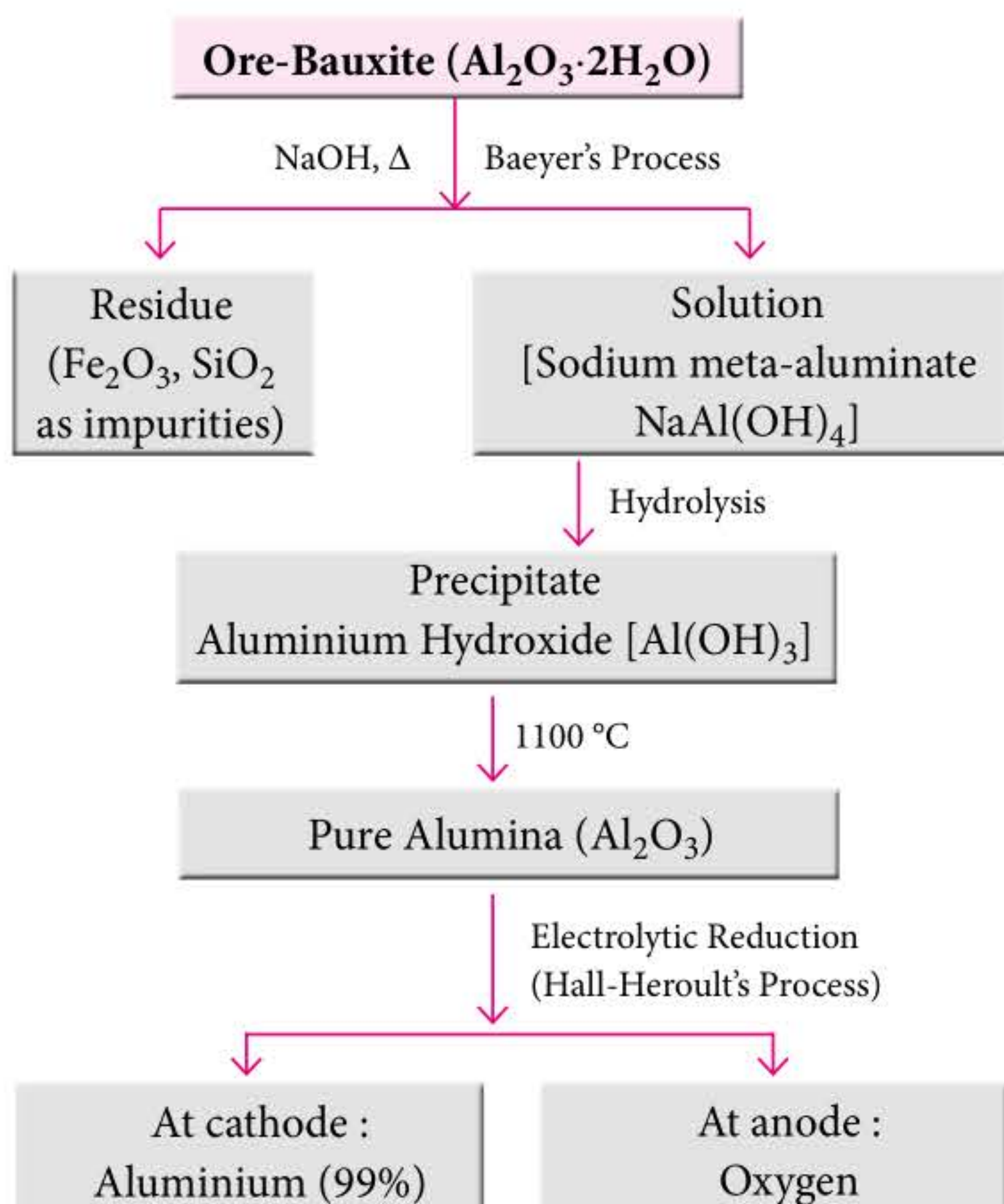
Purification or Refining

| Methods | Metals Purified |
|--------------|--|
| Liquation | For metals having low melting points (like Sn, Pb, Hg, etc) than impurities. |
| Distillation | For volatile metals like Zn, Hg, Cd, etc., or metals containing non-volatile impurities. |
| Poling | For metals which contain impurities of their own oxides <i>e.g.</i> , Cu. |

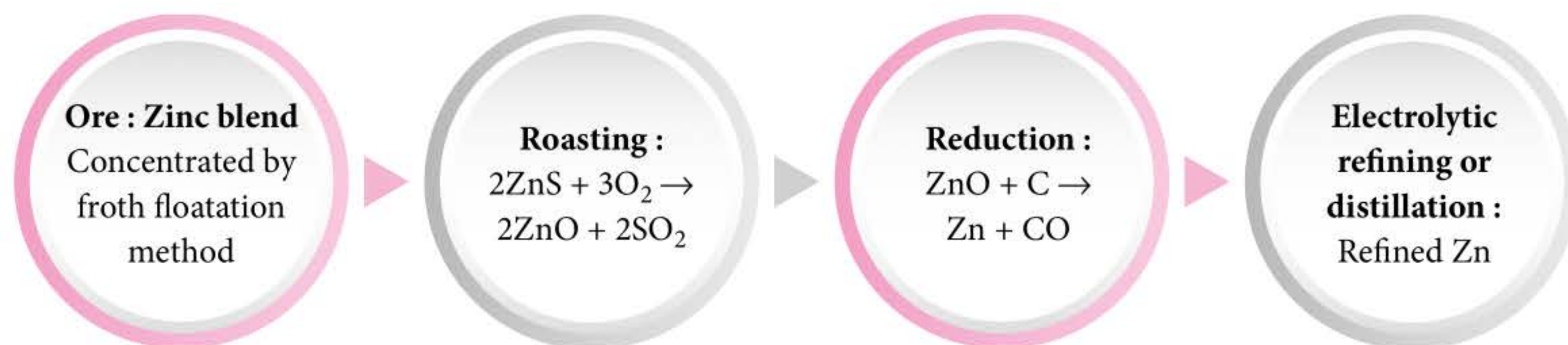
| | |
|-----------------------|---|
| Cupellation | For metals containing easily oxidisable impurities <i>e.g.</i> , Ag containing Pb impurities. |
| Electrolytic refining | For metals like Cu, Ag, Au, Al which get deposited at cathode and impurities get deposited under anode as anode mud. Solution of a soluble metal salt acts as electrolyte. |
| Mond's process | For refining of Ni. $4\text{CO} + \text{Ni} \xrightarrow{60^\circ - 80^\circ\text{C}} \text{Ni}(\text{CO})_4 \xrightarrow{180^\circ\text{C}} 4\text{CO} + \text{Ni}$ Impure Pure |
| Zone refining | To produce extremely pure metals (semiconductors) like Si, Ge, Ga, etc. |
| van Arkel method | For ultra-pure metals like Ti, Zr which are used in space technology. $\text{Ti}_{(\text{s})} + 2\text{I}_{2(\text{g})} \xrightarrow{523\text{K}} \text{TiI}_{4(\text{g})} \xrightarrow{1673\text{K}} \text{Ti}_{(\text{s})} + 2\text{I}_{2(\text{g})}$ Impure Pure $\text{Zr} + 2\text{I}_2 \xrightarrow{870\text{K}} \text{ZrI}_4 \xrightarrow{1800\text{K}} \text{Zr}_{(\text{s})} + 2\text{I}_{2(\text{g})}$ Impure Pure (Vapour) |

EXTRACTION OF SOME IMPORTANT ELEMENTS

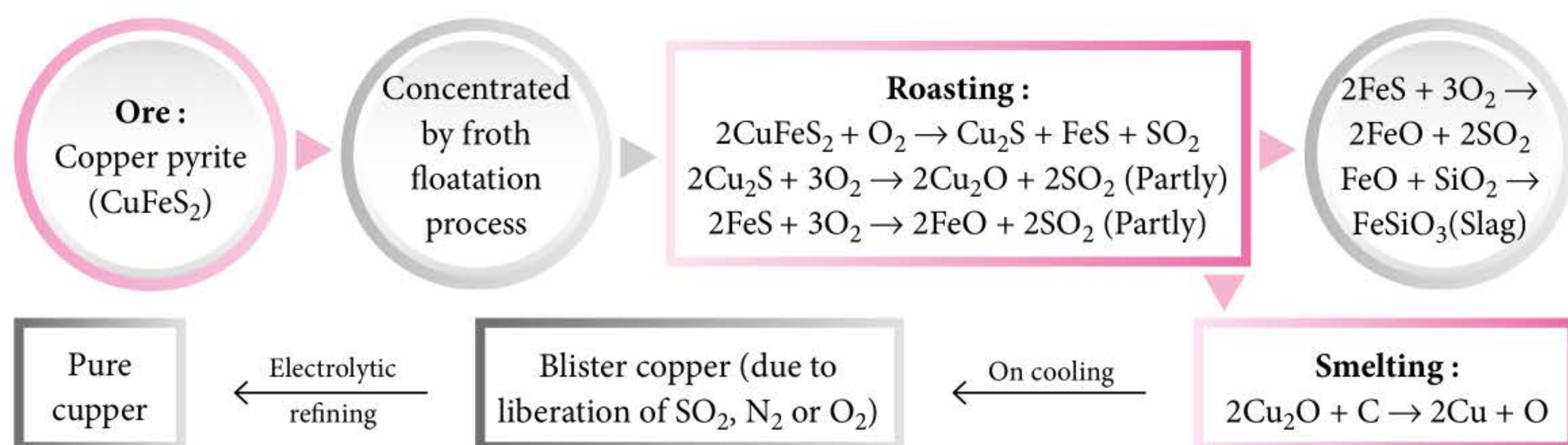
Extraction of Aluminium



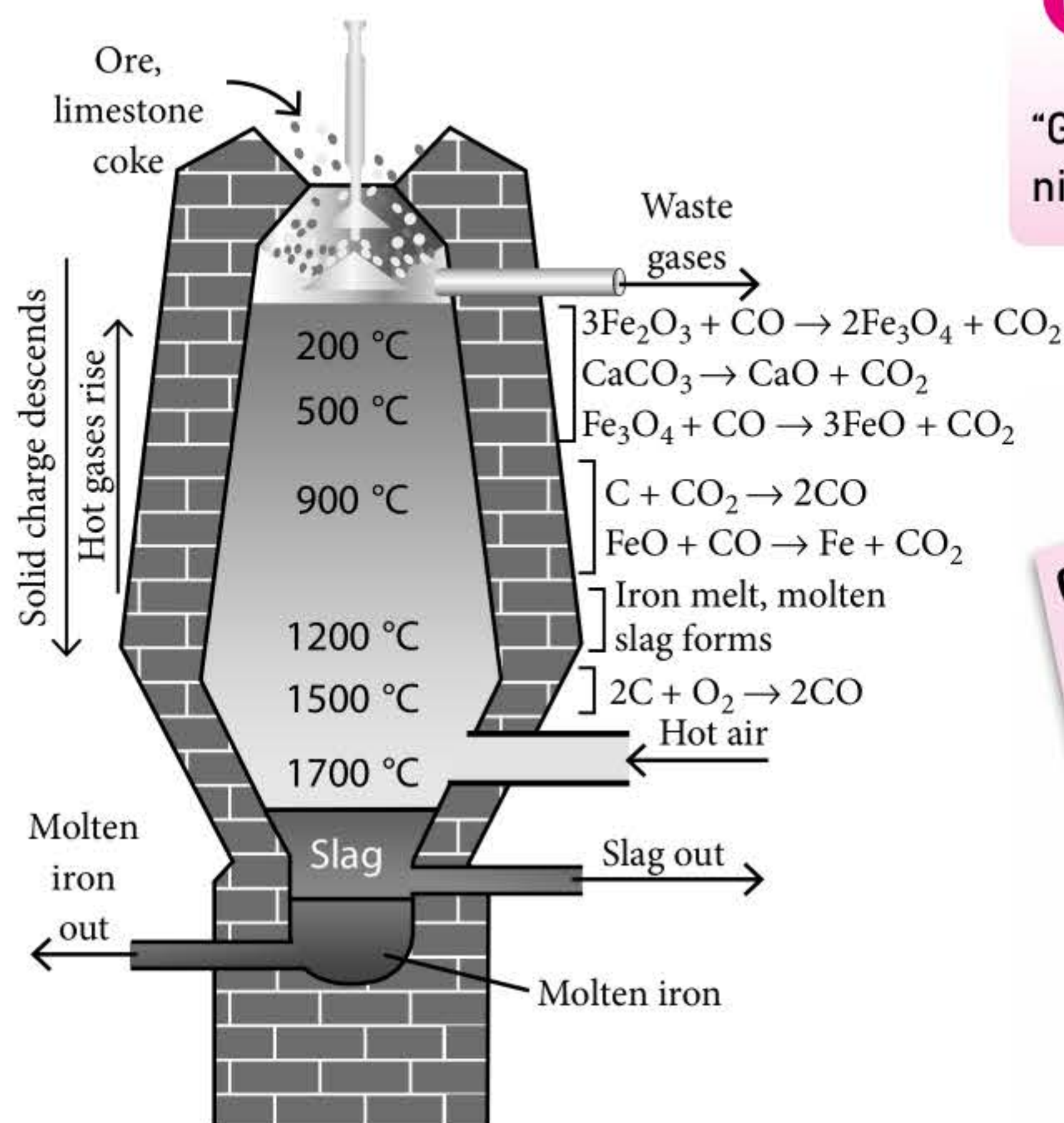
Extraction of Zinc



Extraction of Copper



Extraction of Iron (Blast furnace)



Quotable Quote

“Genius is one percent inspiration and ninety-nine percent perspiration.”

Thomas Edison

GLIMPSE OF NEXT ISSUE...

Focus NEET JEE (XI) : Equilibrium
Redox Reactions

Focus NEET JEE (XII) : The *d*- & *f*-Block Elements
Coordination Compounds

Monthly Tune Up (XI) : States of Matter
Thermodynamics

Monthly Tune Up (XII) : The *p*-Block Elements
(Group 15 to 18)

Concept Map : Some Basic Concepts of Chemistry