Applications

(a) Extraction of iron from its oxides

- **These reactions can be summarized as follows:**
- **At 900 – 1500 K (higher temperature range in the blast furnace):**

$$C + CO_2 \rightarrow 2CO$$

$$FeO + CO \rightarrow Fe + CO_2$$

(a) Extraction of iron from its oxides

- **Limestone is also decomposed to CaO which removes silicate impurity of the ore as slag**
- **The slag is in molten state and separates out from iron**
- **The iron obtained from Blast furnace contains about 4% carbon and many impurities in smaller amount (e.g., S, P, Si, Mn)**
- **This is known as pig iron and cast iron into variety of shapes.**

(a) Extraction of iron from its oxides

- **Cast iron is different from pig iron and is made by melting pig iron with scrap iron and coke using hot air blast.**
- **It has slightly lower carbon content (about 3%) and is extremely hard and brittle.**

Further Reductions

- Wrought iron or malleable iron is the purest form of commercial iron and is prepared from cast iron by oxidising impurities in a reverberatory furnace lined wit
- This haematite oxid
  Fe_2C
- Limestone is ad phosphorus are oxidised and passed i
- The metal is removed and ed from the slag by passing through rollers.

Wrought iron is purest form of iron. It contains Fe – 99.5%, C= 0.1 –0.25% and Mn, P, Si.

MCQs

1) Iron is extracted from magnetite by reduction with..

a) C

b) Mg

c) Al

d) H_2

2) The most pure form of iron is…

✔ **a) wrought iron**

b) mild steel

c) hard steel

d) cast iron

THERMODYNAMIC PRINCIPLES OF METALLURGY

1. EXTRACTION OF COPPER FROM ITS SULPHIDE

Applications

(b) Extraction of copper from cuprous oxide [copper (I) oxide]

- In the graph of $\Delta_r G^{\ominus}$ vs T for formation of oxides (Fig. 6.4), the Cu_2O line is almost at the top
- So, it is quite easy to reduce oxide ores of copper directly to the metal by heating with coke (both the lines of C, CO and C, CO_2 are at much lower positions in the graph particularly after 500 – 600K)
- However, most of the ores are sulphides and some may also contain iron

Applications

(b) Extraction of copper from cuprous oxide [copper (I) oxide]

- **The sulphide ores are roasted/melted to give oxides:**

$$2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$$

- **The oxide can then be easily reduced to metallic copper using coke:**

$$Cu_2O + C \rightarrow 2Cu + CO$$

Applications

(b) Extraction of copper from cuprous oxide [copper (I) oxide]

- **In actual process, the ore is heated in a reverberatory furnace after mixing with silica**
- **In the furnace, iron oxide reacts with silica and form iron silicate (slag) and copper is produced in the form of copper matte**
- **This contains Cu_2S and little FeS**

$$FeO + SiO_2 \rightarrow \underset{\text{Slag}}{FeSiO_3}$$

Applications

(b) Extraction of copper from cuprous oxide [copper (I) oxide]

- **Copper matte is then charged into silica lined convertor.**
- **Some silica is also added and hot air blast is blown to convert the remaining FeS_2, FeO and Cu_2S/Cu_2O to the metallic copper.**

Applications

(b) Extraction of copper from cuprous oxide [copper (I) oxide]

Following reactions take place:

$$2FeS + 3O_2 \rightarrow 2FeO + 2SO_2$$

$$FeO + SiO_2 \rightarrow FeSiO_3$$

$$2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$$

$$2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$$

- **The solidified copper obtained has blistered appearance due to the evolution of SO_2 and so it is called blister copper.**

Applications

(b) Extraction of zinc blende [copper (I) oxide]

The reduction of zinc oxide is done using coke.

- **The temperature in this case is higher than that in case of copper.**
- **For the purpose of heating, the oxide is made into brickette with coke and clay.**

$$ZnO + C \xrightarrow{\text{coke, 673K}} Zn + CO$$

- **The metal is distilled off and collected by rapid chilling.**

MCQs

1) The copper metal is extracted from its

a) Carbonate ore

b) Sulphide ore ✓

c) Sulphate ore

d) Chloride ore

2) The impurity present in Blister copper is

a) FeS

b) Cu_2O

c) Cu_2S

d) FeO

ELECTROCHEMICAL PRINCIPLES OF METALLURGY

1. ALUMINIUM

Electrochemical Principles of Metallurgy

- **We have seen how principles of thermodyamics are applied to pyrometallurgy**
- **Similar principles are effective in the reductions of metal ions in solution or molten state**
- **Here they are reduced by electrolysis or by adding some reducing element**

Electrochemical Principles of Metallurgy

- In the reduction of a molten metal salt, electrolysis is done
- Such methods are based on electrochemical principles which could be understood through the equation

$$\Delta G^{\Theta} = - nE^{\Theta}F$$

- here n is the number of electrons and E^{Θ} is the electrode potential of the redox couple formed in the system
- More reactive metals have large negative values of the electrode potential

Electrochemical Principles of Metallurgy

- **So, their reduction is difficult.**
- **If the difference of two $E^{\ominus}$ values corresponds to a positive $E^{\ominus}$ and consequently negative $\Delta G^{\ominus}$ then the less reactive metal will come out of the solution and the more reactive metal will go to the solution, e.g.,**

$$Cu^{2+}(aq) + Fe(s) \rightarrow Cu(s) + Fe^{2+}(aq)$$

Electrochemical Principles of Metallurgy

- **In simple electrolysis, the Mn^{+2} ions are discharged at negative electrodes (cathodes) and deposited there**
- **Precautions are taken considering the reactivity of the metal produced and suitable materials are used as electrodes**
- **Sometimes a flux is added for making the molten mass more conducting**

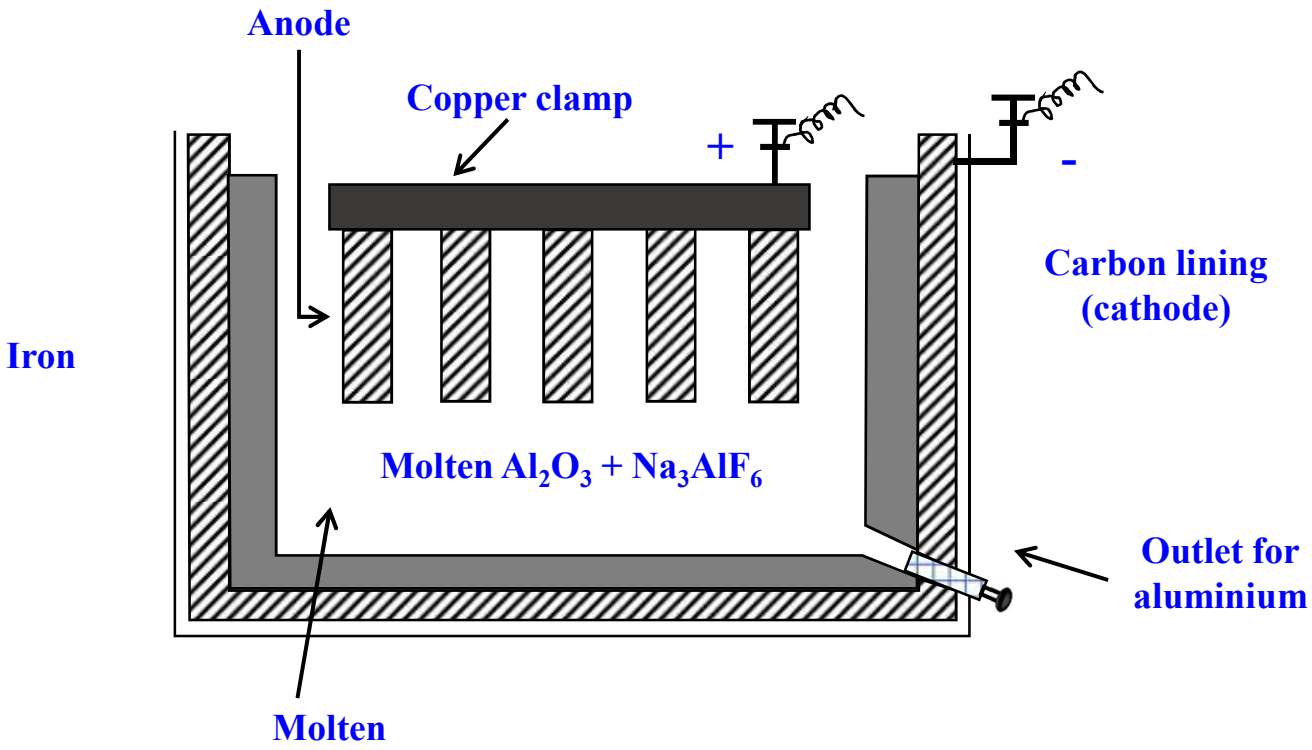
Aluminium

- In the metallurgy of aluminium, purified Al_2O_3 is mixed with Na_3AlF_6 or CaF_2 which lowers the melting point of the mix and brings conductivity
- The fused matrix is electrolyzed
- Steel cathode and graphite anode are used
- The graphite anode is useful here for reduction to the metal
- The overall reaction may be taken as:

Aluminium

$2Al_2O_3 + 3C \rightarrow 4Al + 3CO_2$

- **This process of electrolysis is widely known as Hall-Heroult process**
- **The electrolysis of the molten mass is carried out in an electrolytic cell using carbon electrodes**
- **The oxygen liberated at anode reacts with the carbon of anode producing CO and CO_2**
- **This way for each kg of aluminium produced, about 0.5 kg of carbon anode is burnt away. The electrolytic reactions are:**


Anode
Copper clamp
+
-
Iron
Carbon lining
(cathode)
Molten $Al_2O_3 + Na_3AlF_6$
Outlet for
aluminium
Molten

Aluminium

Cathode:

$$Al^{3+}\,(melt) + 3e^- \rightarrow Al\,(l)$$

Anode:

$$C\,(s) + \frac{1}{2}O_2\,(molten) \rightarrow CO\,(g) + 2e^-$$

$$C\,(s) + O_2^{-2}\,(molten) \rightarrow CO_2\,(g) + 4e^-$$

MCQs

1) The electrolyte used in the extraction of Aluminium

a) Fused cryolite with felspar

b) Fused cryolite with fluorspar

c) ✓ Pure alumina in molten cryolite with fluorospar

d) Pure alumina with bauxite and molten cryolite

2) The non-metal present in cryolite is…

a) Aluminium

b) Chlorine

c) Bromine

d) Flourine

3) Cryolite and fluorspar is added to electrolyte in electrolytic refining of aluminum is because …

a) To increase the conductivity of the electrolyte

b) To decrease the conductivity of the electrolyte

c) To get 100 % pure metal

d) To remove all the impurities from the electrolyte

COPPER FROM
LOW GRADE ORES AND SCRAPS
1. OXIDATION & REDUCTION

Copper from Low Grade Ores and Scraps

- **Copper is extracted by hydro metallurgy from low grade ores. It is leached out using acid or bacteria**
- **The solution containing Cu^{2+} is treated with scrap iron or H_2**

$$Cu^{2+}(aq) + H_2(g) \rightarrow Cu(s) + 2H^+(aq)$$

Question

At a site, low grade copper ores are available and zinc and iron scraps are also available. Which of the two scraps would be more suitable for reducing the leached copper ore and why?

Answer:

Zinc being above iron in the electrochemical series (more reactive metal is zinc), the reduction will be faster in case zinc scraps are used. But, zinc is costlier metal than iron so using iron scraps will be advisable and advantageous.

Oxidation Reduction

- **Besides reductions, some extractions are based on oxidation particularly for non-metals**
- **A very common example of extraction based on oxidation is the extraction of chlorine from brine (chlorine is abundant in sea water as common salt)**

$$2Cl^-(aq) + 2H_2O(l) \rightarrow 2OH^-(aq) + H_2(g) + Cl_2(g)$$

- **The ΔG^{Θ} for this reaction is + 422 kJ**

Oxidation Reduction

- When it is converted to E^{Θ} (using $\Delta G^{\Theta} = -nE^{\Theta}F$), we get $E^{\Theta} = -2.2$ V
- Naturally, it will require an external e.m.f. that is greater than 2.2 V
- But the electrolysis requires an excess potential to overcome some other hindering reactions
- Thus, Cl_2 is obtained by electrolysis giving out H_2 and aqueous NaOH as by products

Oxidation Reduction

- **Electrolysis of molten NaCl is also carried out**
- **But in that case, Na metal is produced and not NaOH**
- **As studied earlier, extraction of gold and silver involves leaching the metal with CN–**
- **This is also an oxidation reaction (Ag → Ag+ or Au → Au+)**

Oxidation Reduction

- **The metal is later recovered by displacement method**

$$4Au(s) + 8CN^-(aq) + 2H_2O(aq) + O_2(g) \rightarrow 4[Au(CN)_2]^-(aq) + 4OH^-(aq)$$

$$2[Au(CN)_2]^-(aq) + Zn\ (s) \rightarrow 2Au\ (s) + [Zn(CN)_4]^{2-}\ (aq)$$

- **In this reaction zinc acts as a reducing agent**

MCQs

1) Cyanamide process is used for the extraction of

a) Ba

b) Al

c) B

d) Ag

2) The metal is extracted by leaching with

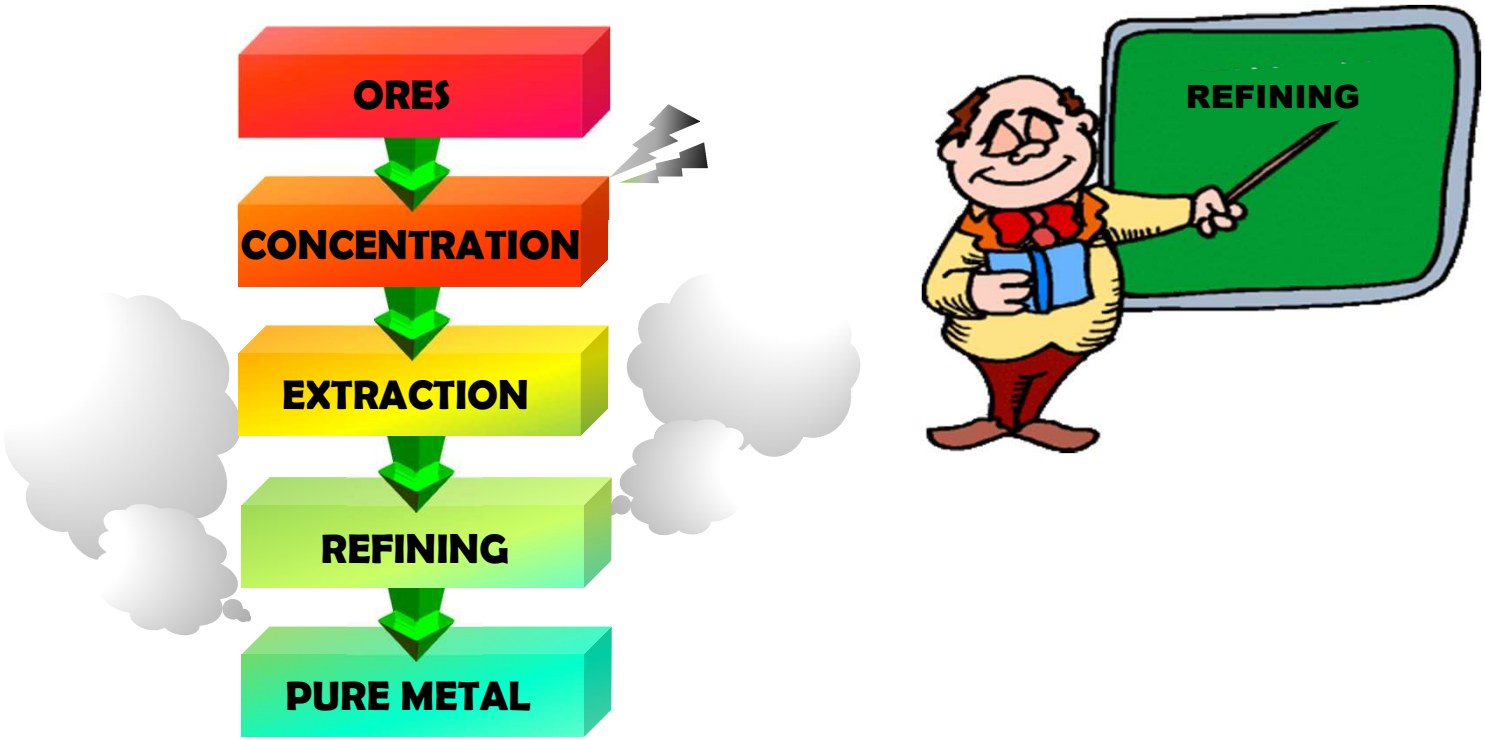
a) cyanide

b) chloride

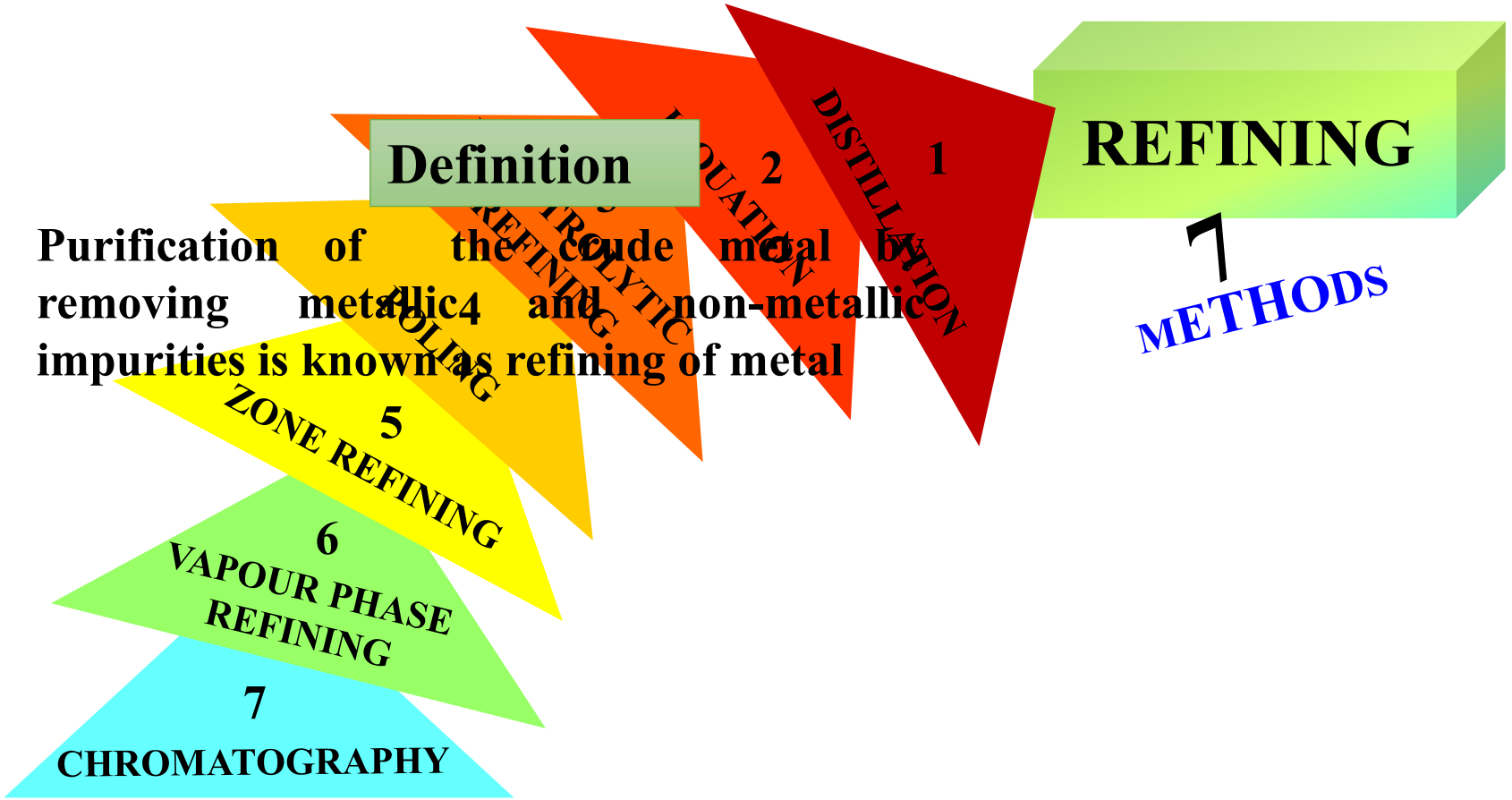
c) bromide

d) fluoride

REFINING METHODS
1.DISTILLATION
2. LIQUATION



General procedure to extract a metal….


REFINING
7
METHODS
Definition
Purification of the crude metal by removing metallic and non-metallic impurities is known as refining of metal
1
DISTILLATION
2
4
5
ZONE REFINING
6
VAPOUR PHASE REFINING
7
CHROMATOGRAPHY

PRINCIPLE

This method is used to remove the

olatile
ities
from
volatile
metals

inc, Cadmium and mercury

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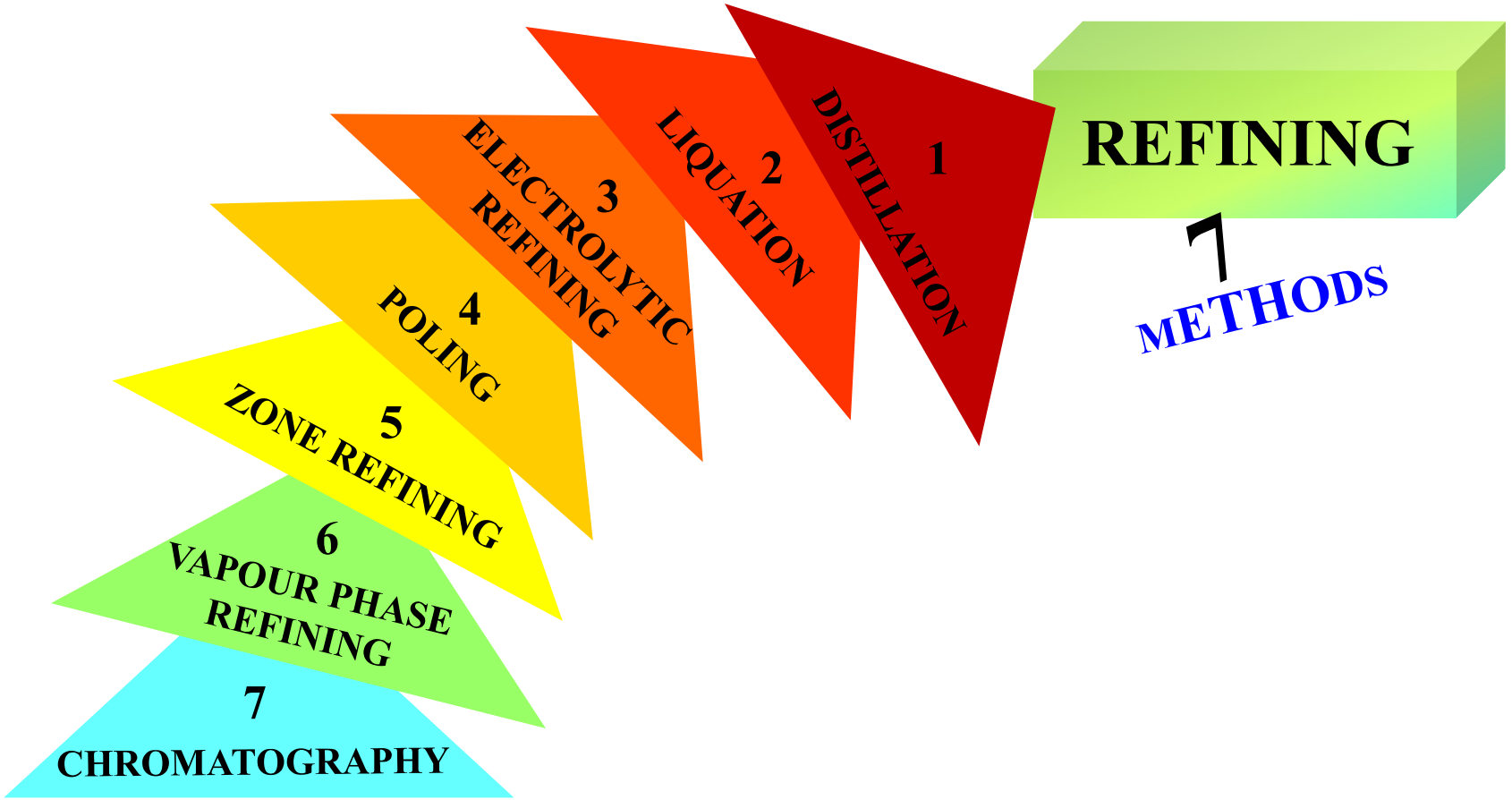
REFINING
7
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1
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LIQUATION
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ELECTROLYTIC REFINING
4
POLING
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ZONE REFINING
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LIQUATION

PRINCIPLE

In this process, the low melting metal forms fusible liquid on heating and flows down.

This method is employed when

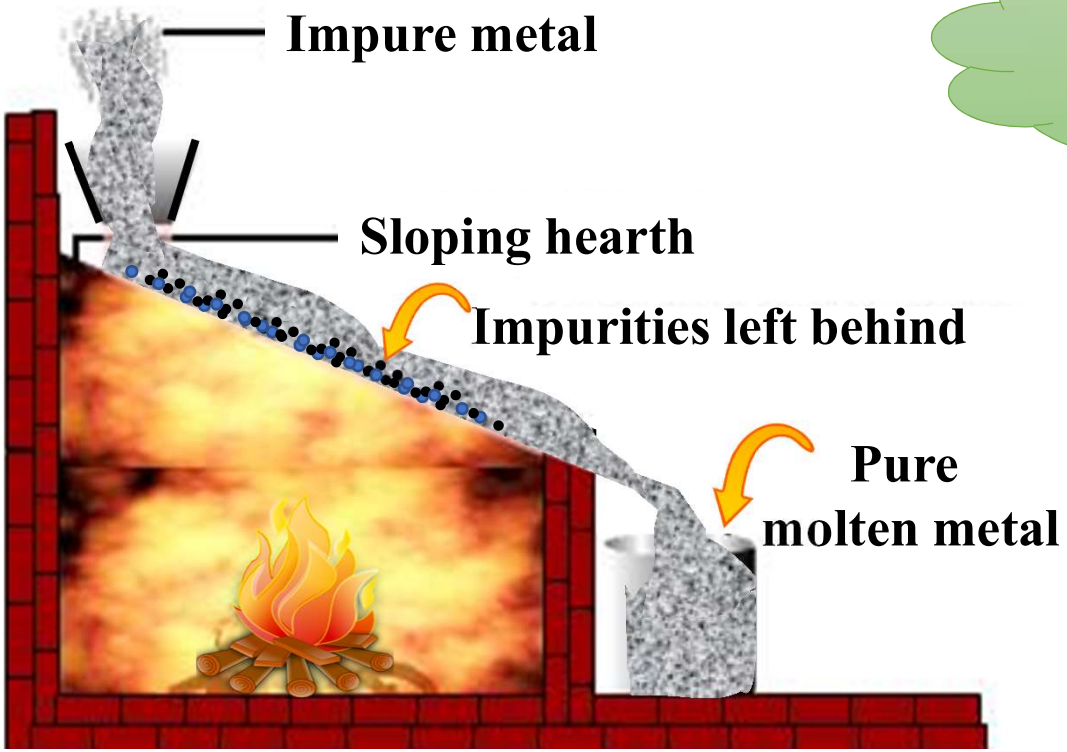
Impurity **HIGHER melting point**

Required metal **LOWER melting point**

Metals like bismuth, tin, lead and mercury are separated from their crude form by Liquation.

LIQUATION

Working



MCQs

1) Liquation method is used to refine following crude metal

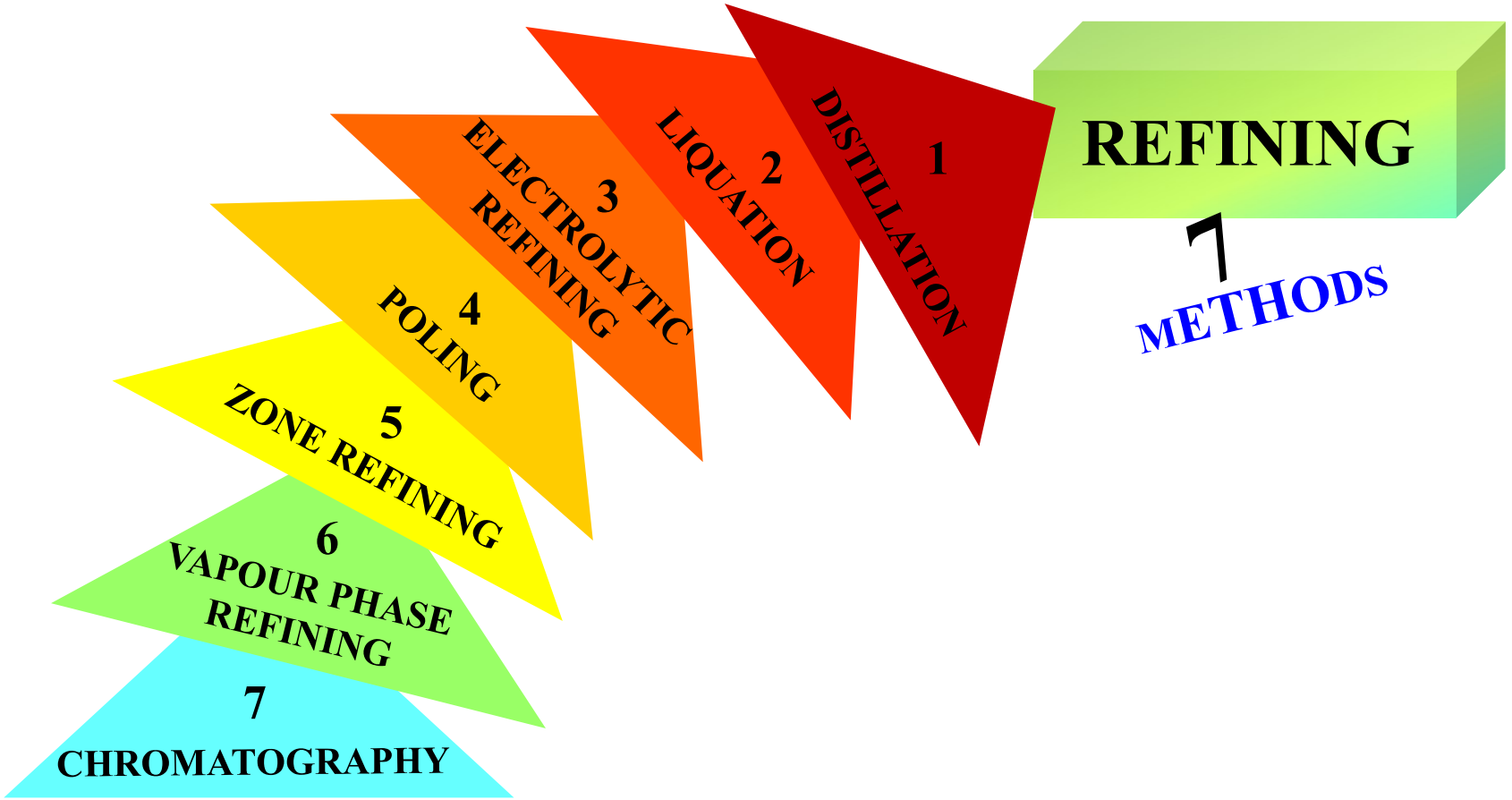
a) Copper


b) Tin

c) Znc

d) All metals

REFINING METHODS
3. ELECTROLYTIC
4. POLLING METHODS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OLYTIC

INCIPLE

s are refined in an
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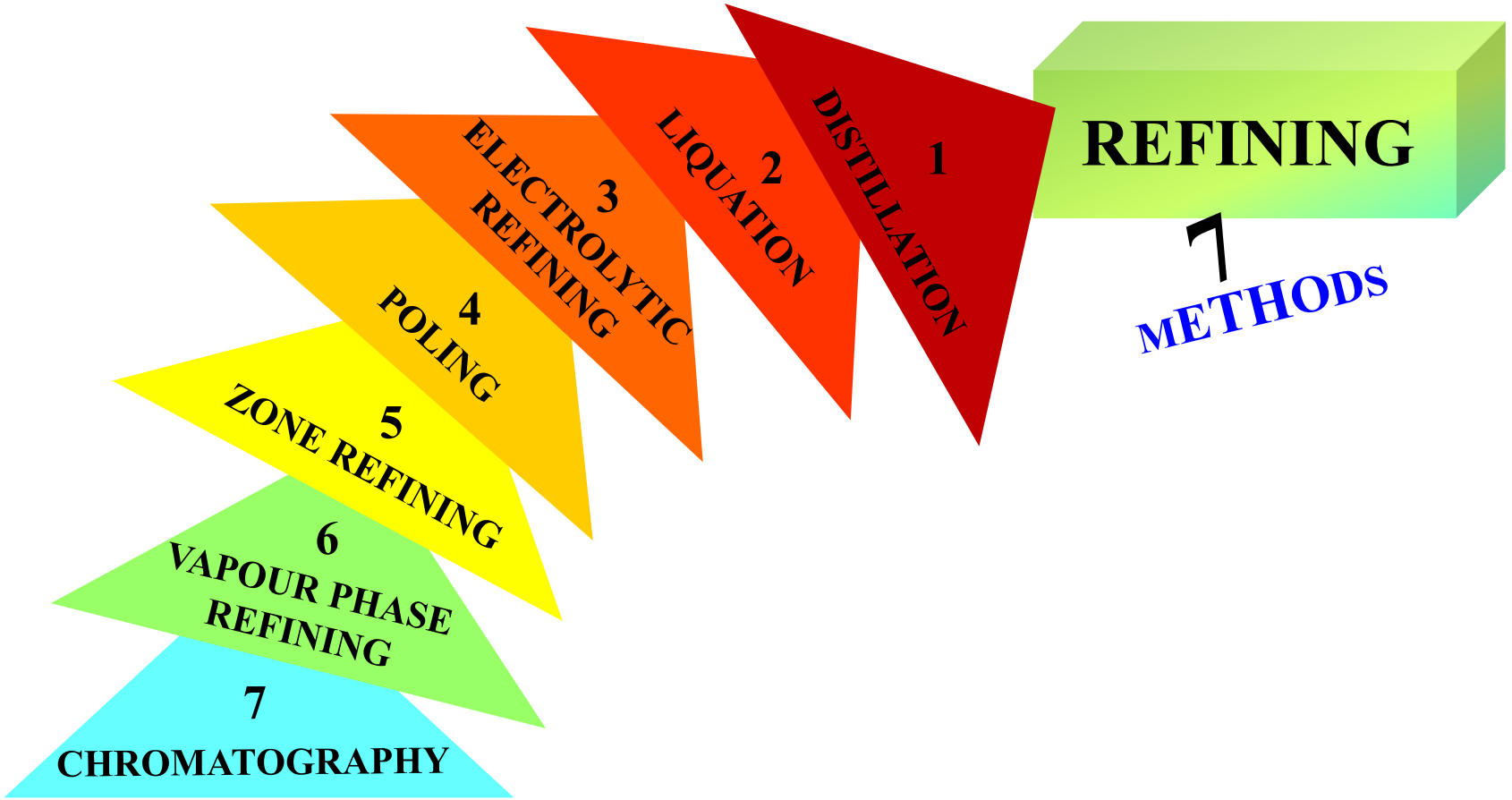
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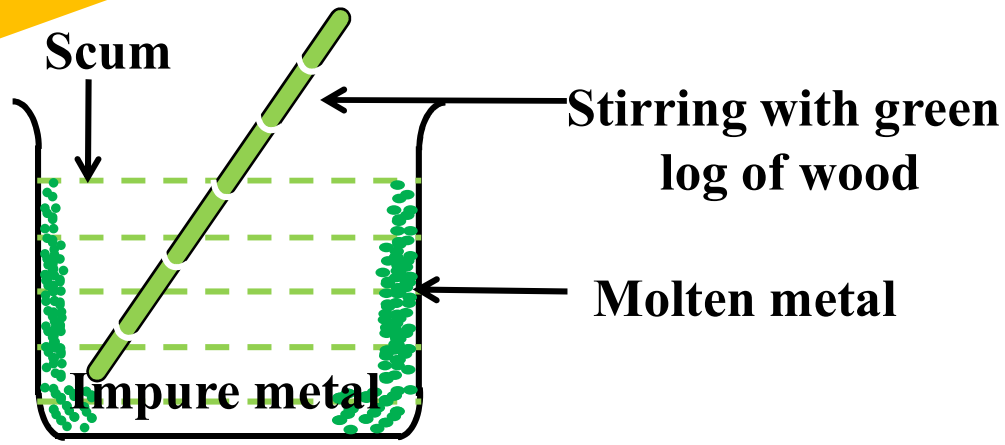
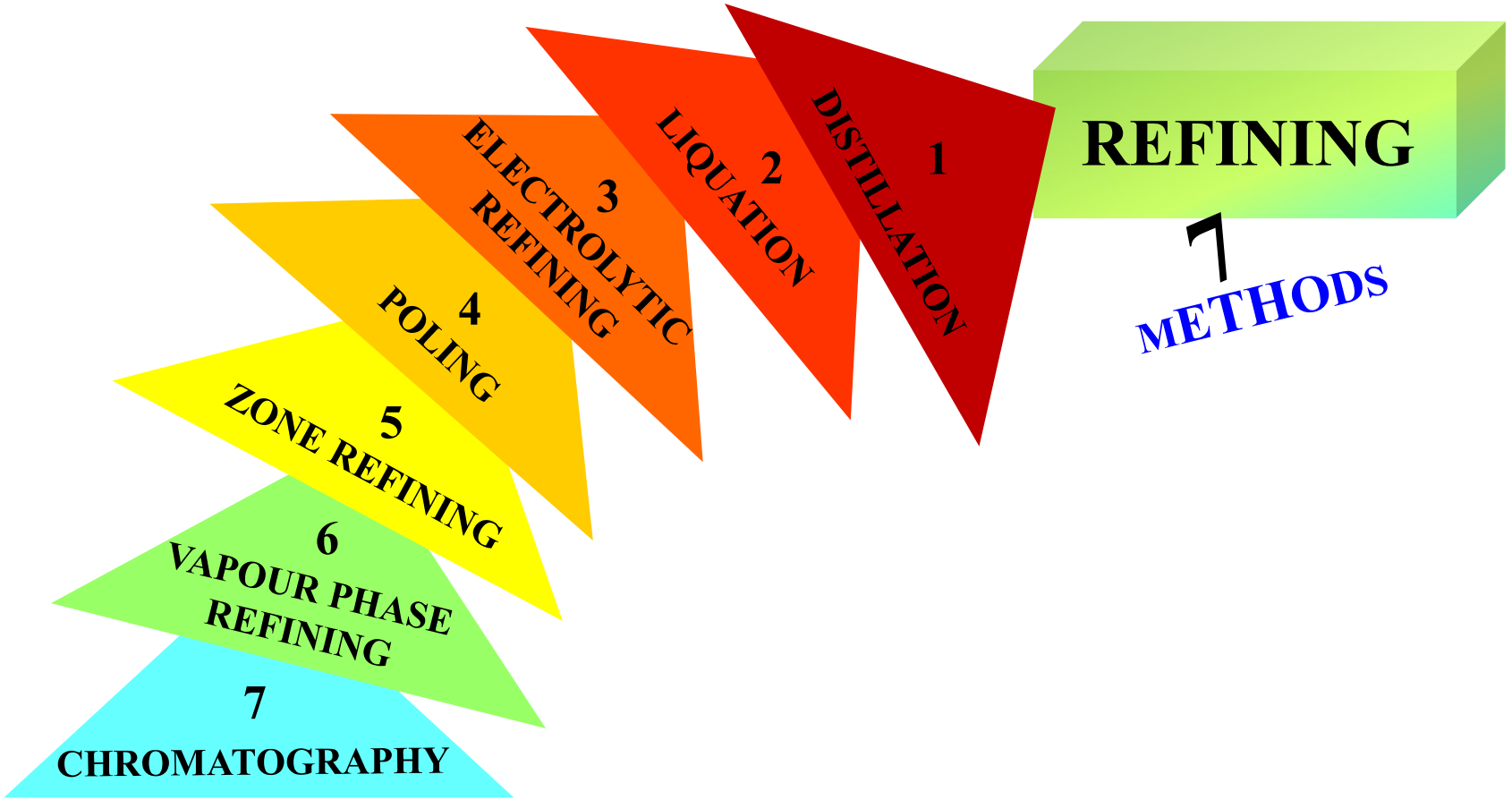
POLING

PRINCIPLE

This method is generally employed in the purification of copper or tin which contain oxide impurities.

The hydrocarbon gases liberated from the green wood reduce the metal oxide into metal.

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CHROMATOGRAPHY

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MCQs

1) The method for the purification of impure metals which is based upon the phenomenon of electrolysis is called

a) Electro-refining

b) hydrometallurgy

c) polling

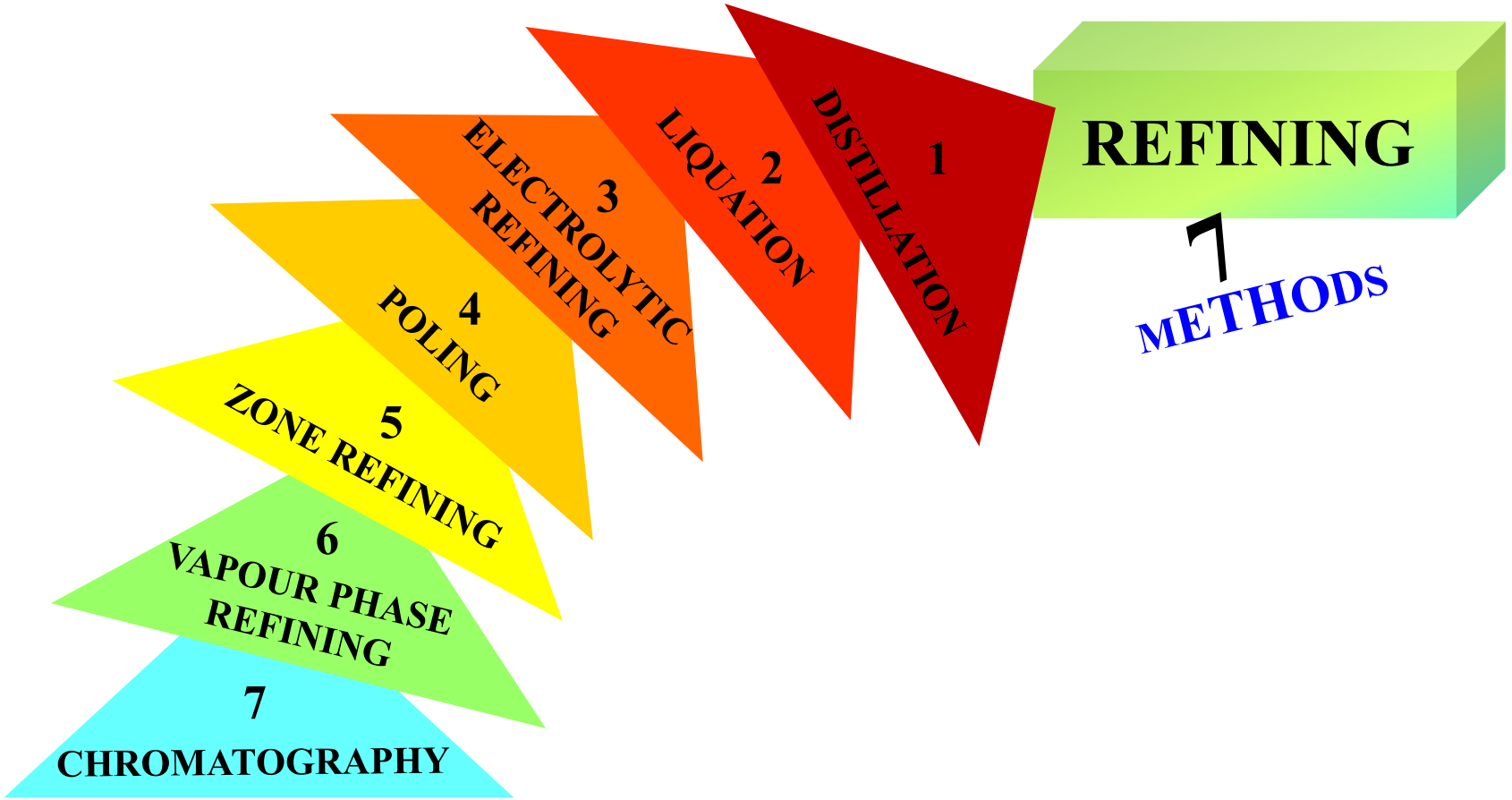
d) liquation

REFINING METHODS

5. ZONE REFINING

6. VAPOUR PHASE

7. CHROMATOGRAPHY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CHROMATOGRAPHY

VAPOUR PHASE REFINING

The volatile compound is then thermally decomposed to give the pure metal.

The metal is converted into a volatile compound and collected elsewhere.

Monds process

Ni & Impurities + $4CO \longrightarrow Ni(CO)_4$

Heat

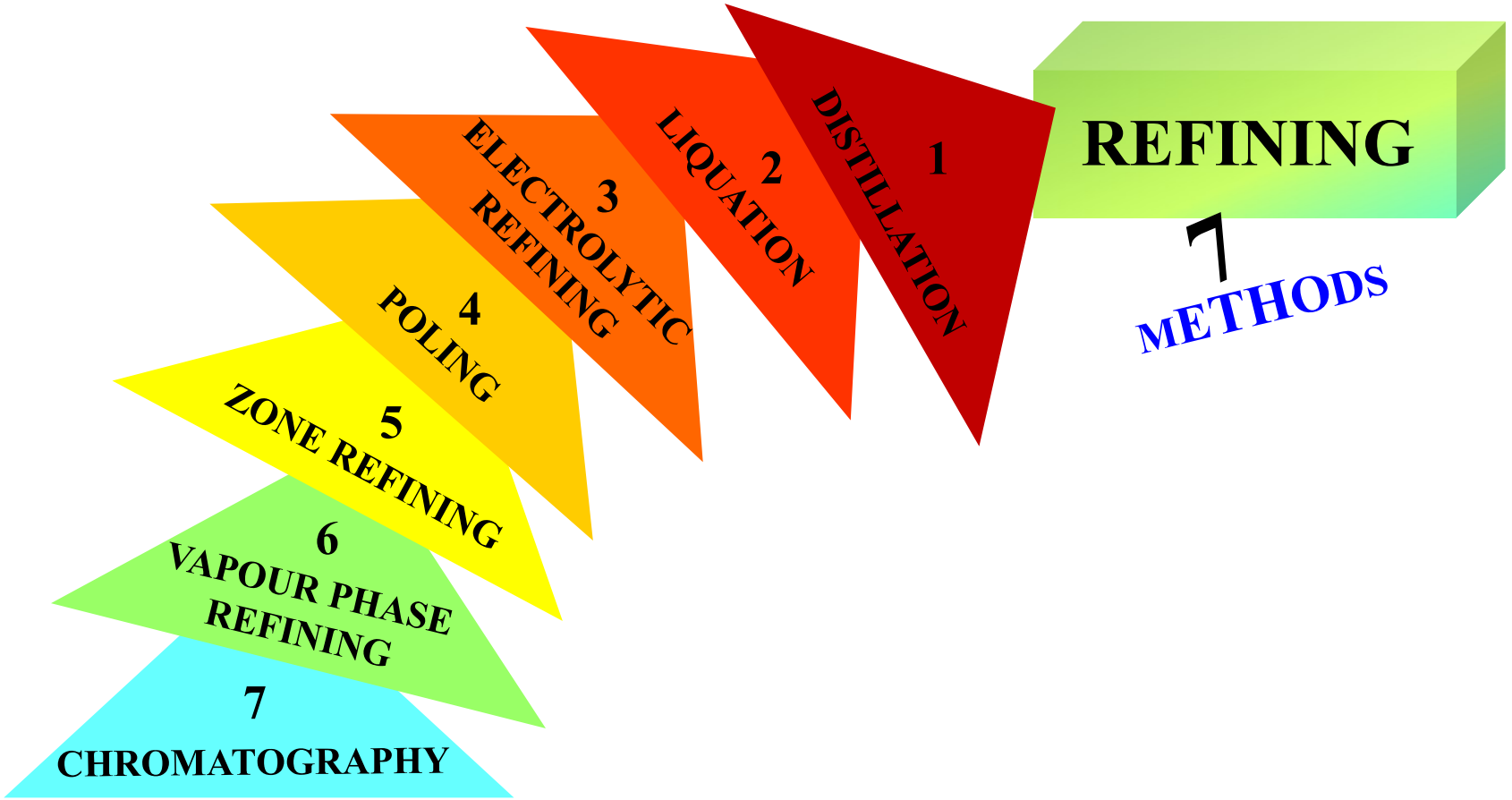
$Ni + 4CO$

Van Arkel method

Zr & Impurities + $2I_2 \longrightarrow ZrI_4$

Heat

$Zr + 2I_2$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VAPOUR PHASE REFINING
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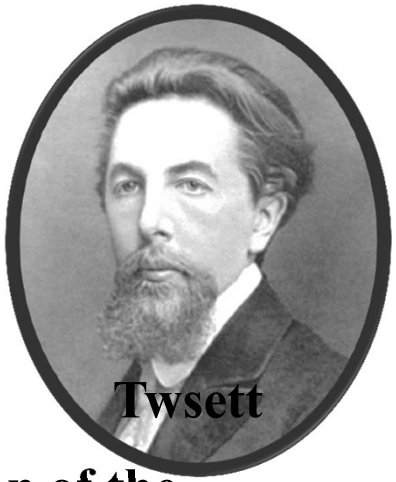
CHROMATOGRAPHY

Column CHROMATOGRAPHY

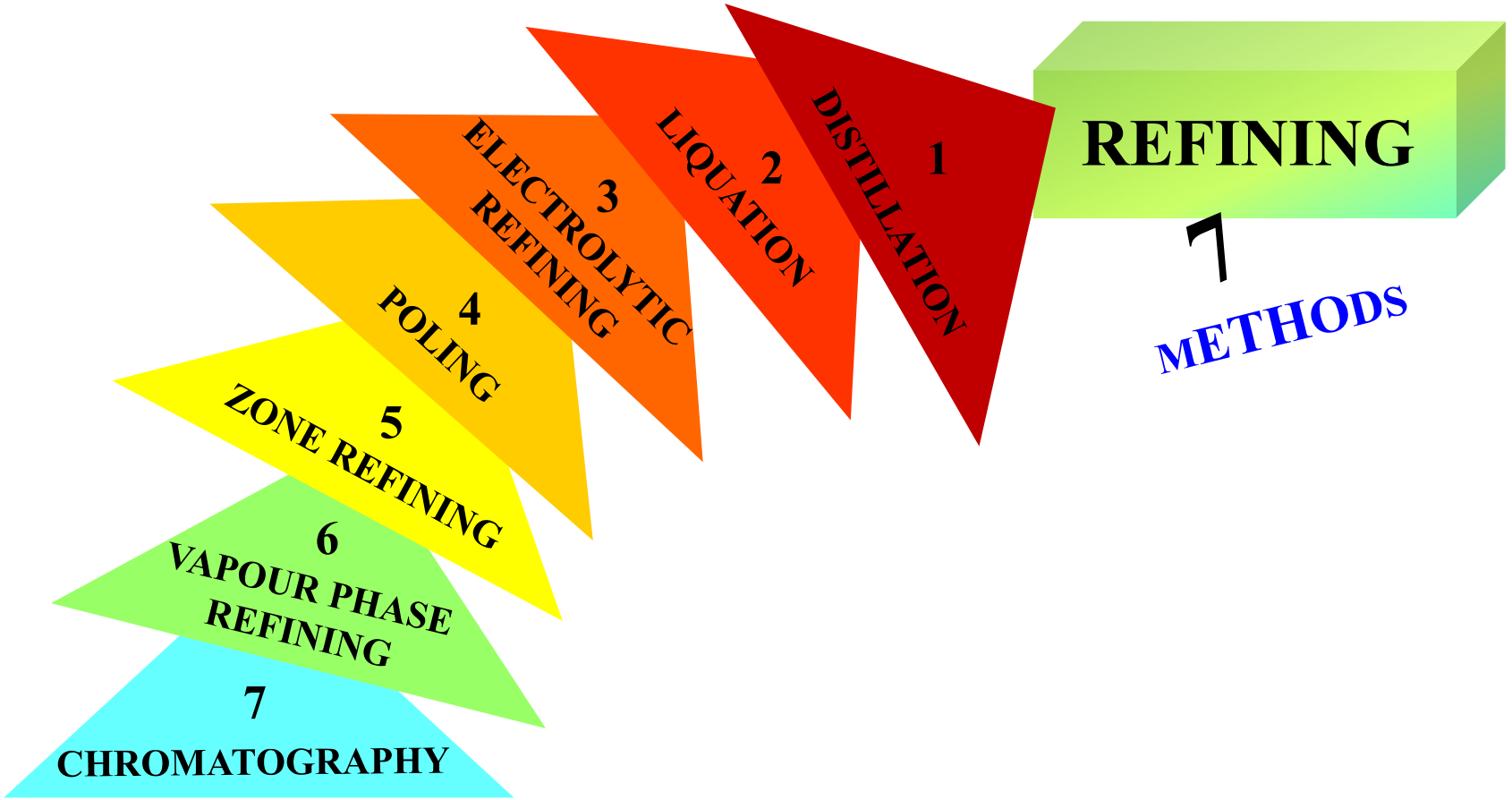


PRINCIPLE

This method is based on the selective adsorption of the components of a mixture.

The different components of a mixture are adsorbed to different extents on an adsorbent.

COLUMN CHROMATOGRAPHY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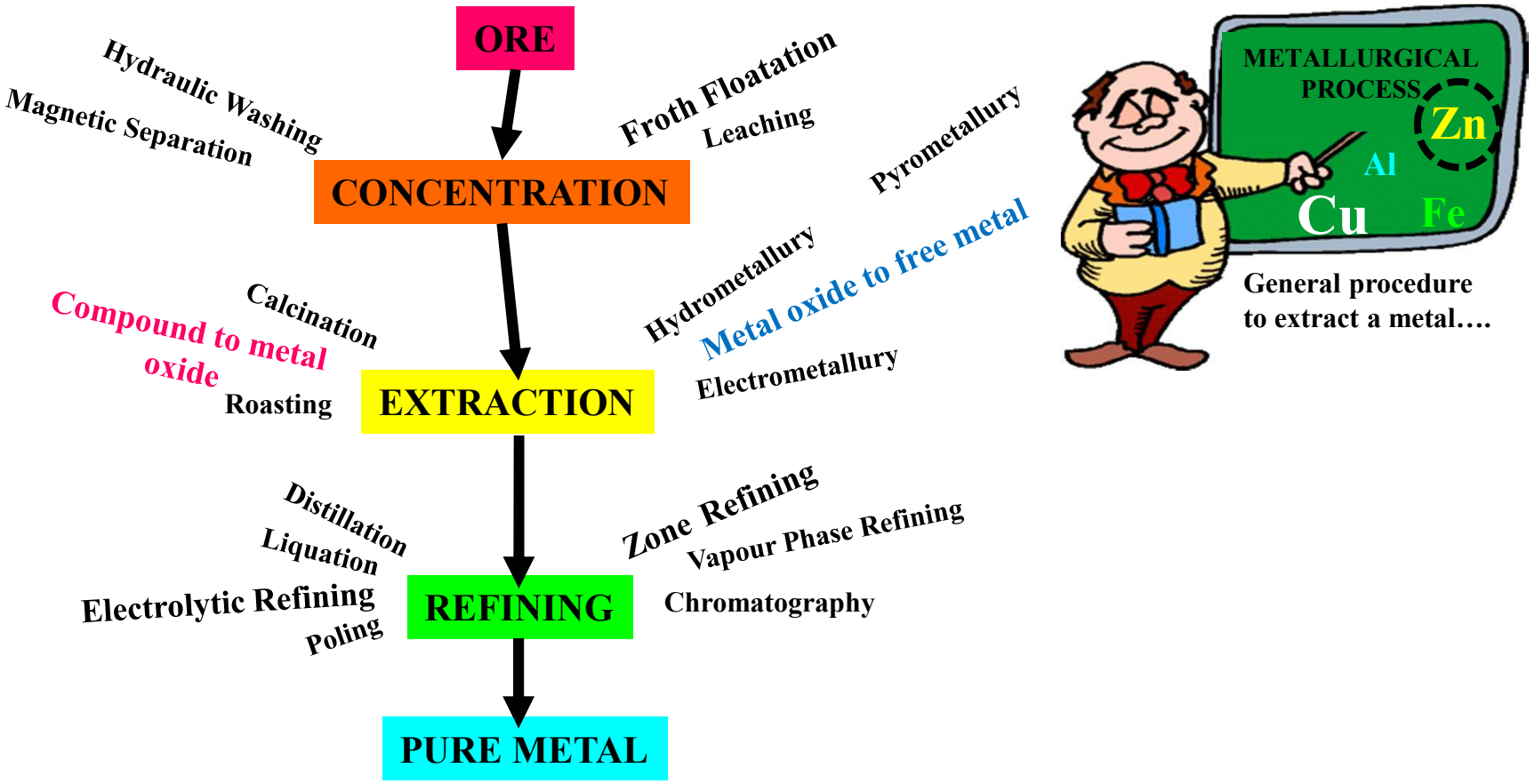

ORE
Hydraulic Washing
Magnetic Separation
Froth Floatation
Leaching
CONCENTRATION
Pyrometallury
Hydrometallury
Metal oxide to free metal
Electrometallury
Calcination
Compound to metal oxide
Roasting
EXTRACTION
Distillation
Liquation
Electrolytic Refining
Poling
Zone Refining
Vapour Phase Refining
Chromatography
REFINING
PURE METAL
METALLURGICAL PROCESS
Zn
Al
Cu
Fe
General procedure to extract a metal….

MCQs

1) Mond's process is used for the purification of

a) Ni

b)Zr

c) Fe

d) Cu

2)Van Arkel process is used for the purification of

a) Ni

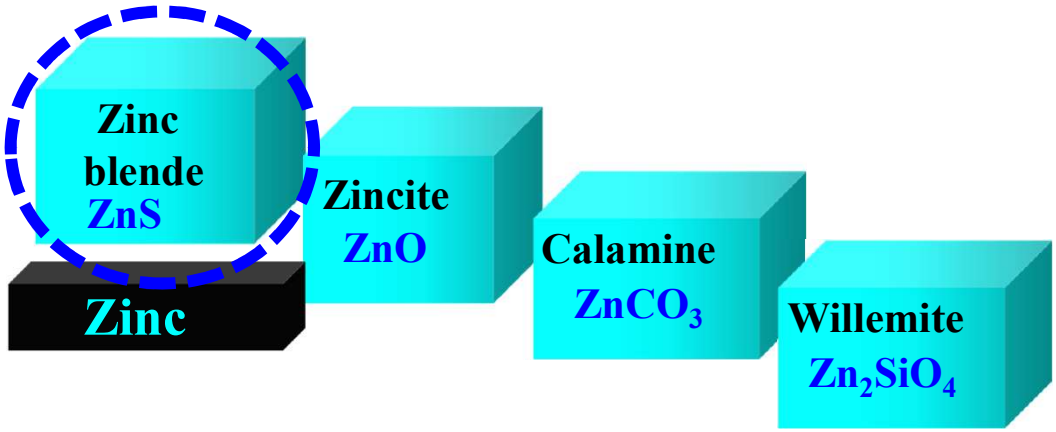
b) Zr

c) Fe

d) Cu

MINERALS & ORES OF ZINC
1. EXTRACTION OF ZINC FROM ZINC BLENDE

Minerals & ores of Zinc



Extraction of zinc from zinc blende

Step 1

Concentration

Gravity process or levigation process:

Removes lighter Guange partilces

Electromagnetic separation :

Iron oxide impurities are removed

Froth floatation :

Because zinc blend is a sulphide ore

Extraction of zinc from zinc blende

Step 2

Extraction

a. Conversion of Ore into Oxide by ROASTING.

In reverberatory furnace at 1200K

$$ZnS + 3\ O_2 \longrightarrow 2\ ZnO + 2\ SO_2$$

$$ZnS + 2\ O_2 \longrightarrow ZnSO_4$$

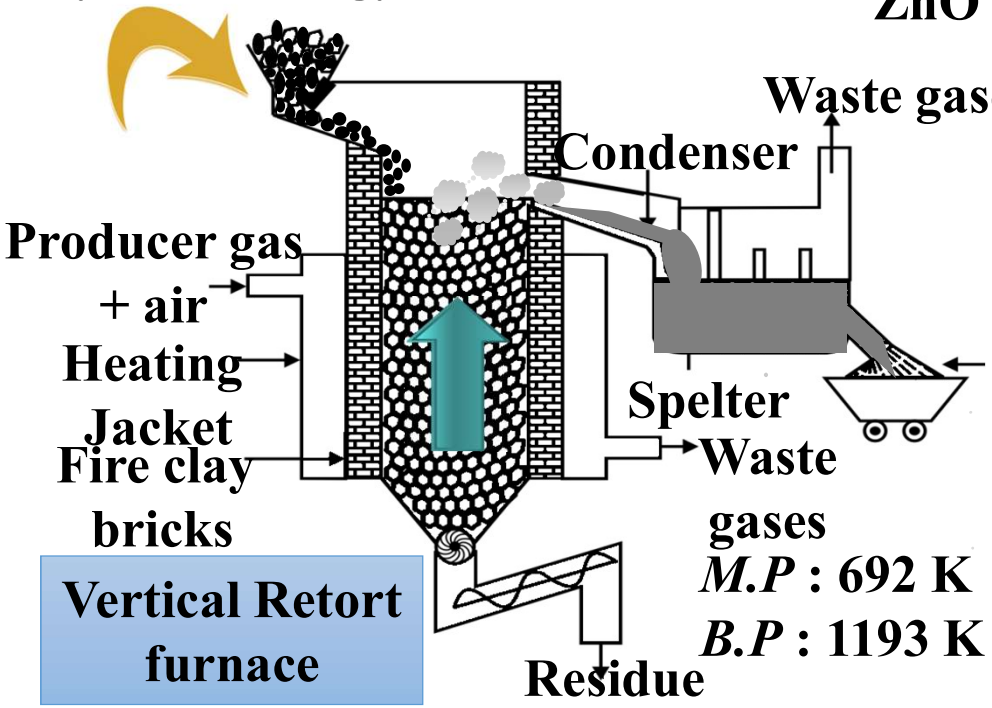
$$2\ ZnSO_4 \xrightarrow{1200K} 2\ ZnO + 2\ SO_2 + O_2$$

b. Conversion of metal oxide into free metal (Reduction)

Pyrometallurgy **smelting**

$$ZnO + C \xrightarrow[1673\ K]{CO + N_2} Zn + CO$$

40% 60%



Vertical Retort furnace

M.P **: 692 K**

B.P **: 1193 K**

Extraction of zinc from zinc blende

Step 3

Refining

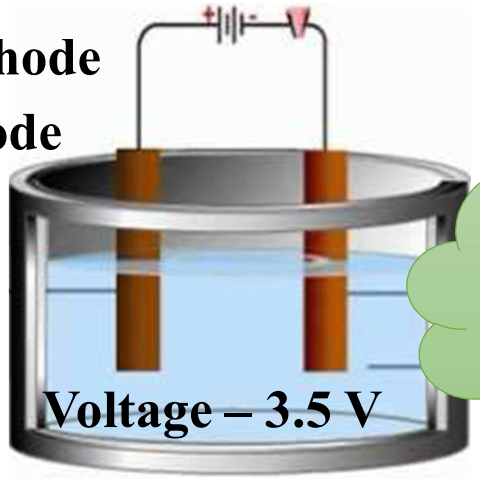
Electrolytic refining

Zinc spelter + dil. H_2SO_4 ⟶ $ZnSO_4$

Electrolytic Solution

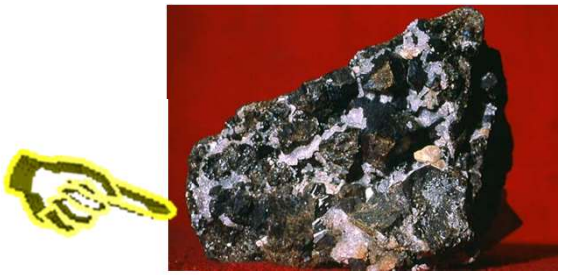
Al - Cathode

Pb - Anode



Pure Zinc is deposited at Al cathode

This is how zinc blende looks like



The zinc metal extracted is used for various reasons in our daily life

Fancy furniture

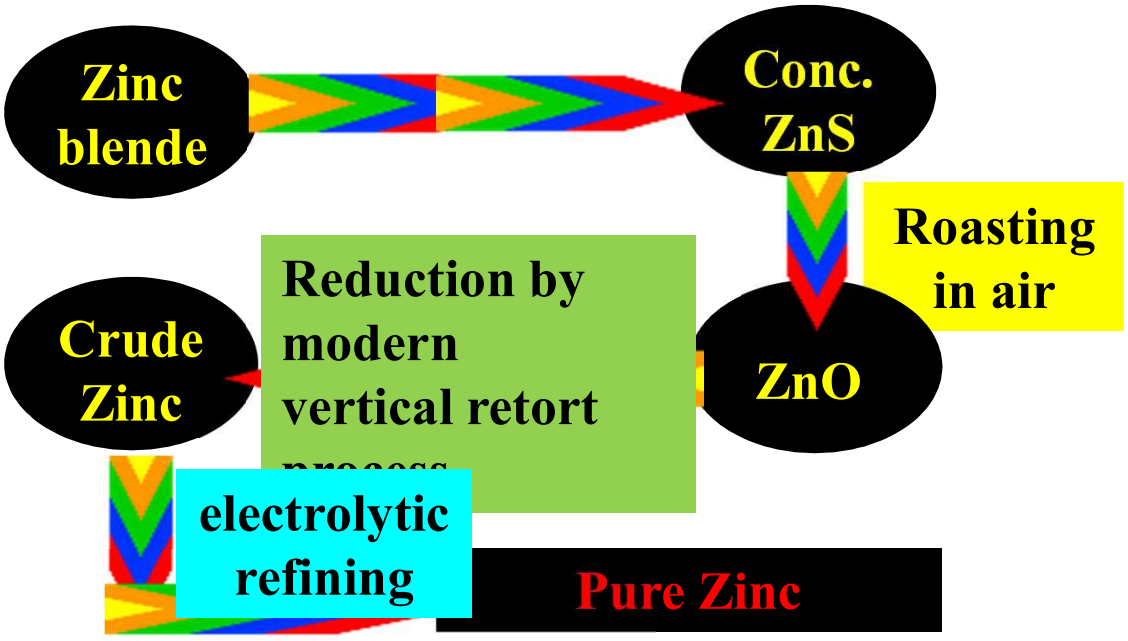
Wall cladding

key chains

Gravity separation

Electromagnetic separation

Froth floatation



Extraction of Zinc from Zinc blende

Uses of zinc

- **Galvanizing Iron**
- **Reducing Agent**
- **Making Alloys like brass, German silver etc.**

MCQs

1) Sulphide ore of Zinc is

a) Zinc blend ✓

b) zincite

c) willimite

d) calamite

2) The furnace used in the extraction of Zn by…

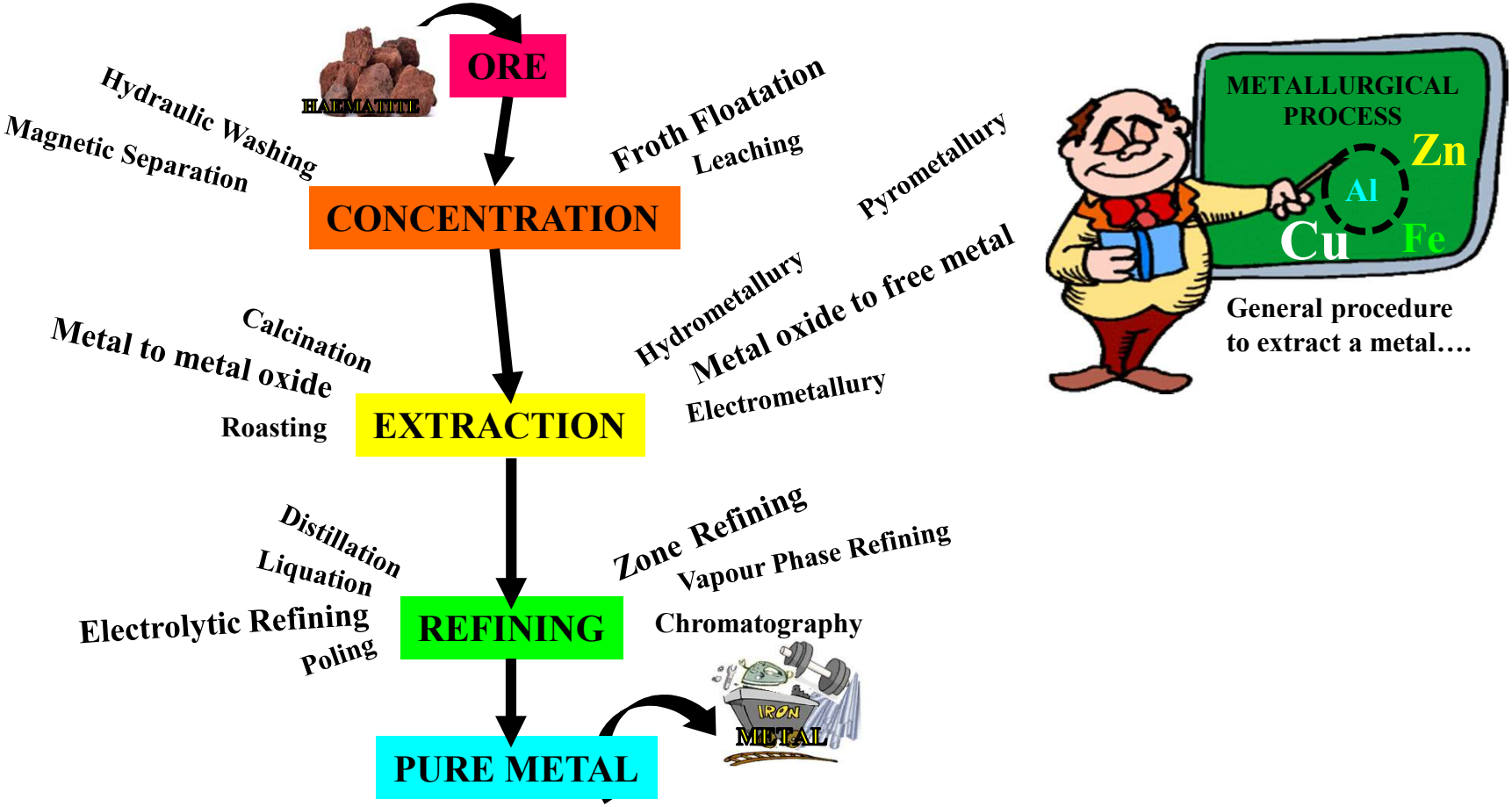
a) Blast furnace

b) Open hearth furnace

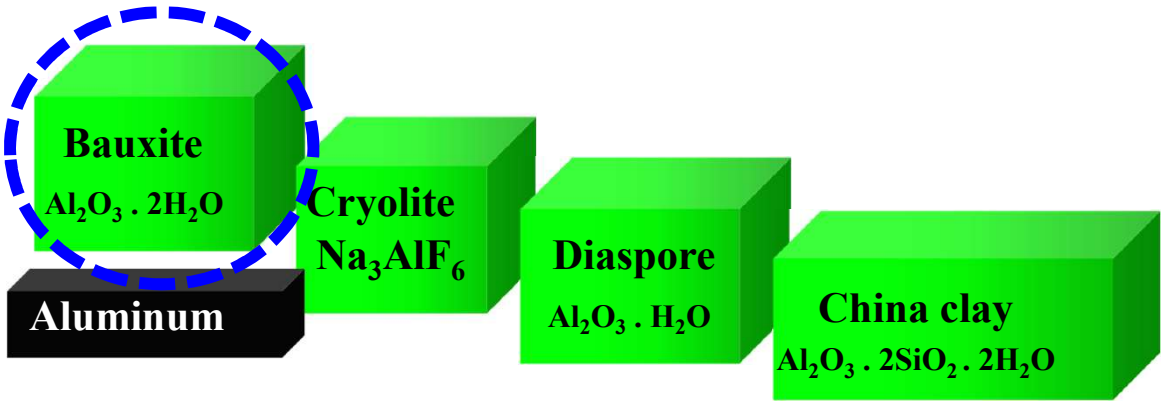
c) Vertical retort process ✓

d) Muffle furnace.

MINERALS & ORES OF ALUMINIUM
1. EXTRACTION OF ALLUMINIUM FROM BAUXITE


HAEMATITE
ORE
Hydraulic Washing
Magnetic Separation
Froth Floatation
Leaching
CONCENTRATION
Pyrometallury
Hydrometallury
Metal oxide to free metal
Electrometallury
Calcination
Metal to metal oxide
Roasting
EXTRACTION
Distillation
Liquation
Electrolytic Refining
Poling
Zone Refining
Vapour Phase Refining
Chromatography
REFINING
IRON
METAL
PURE METAL
METALLURGICAL PROCESS
Zn
Al
Cu
Fe
General procedure to extract a metal….

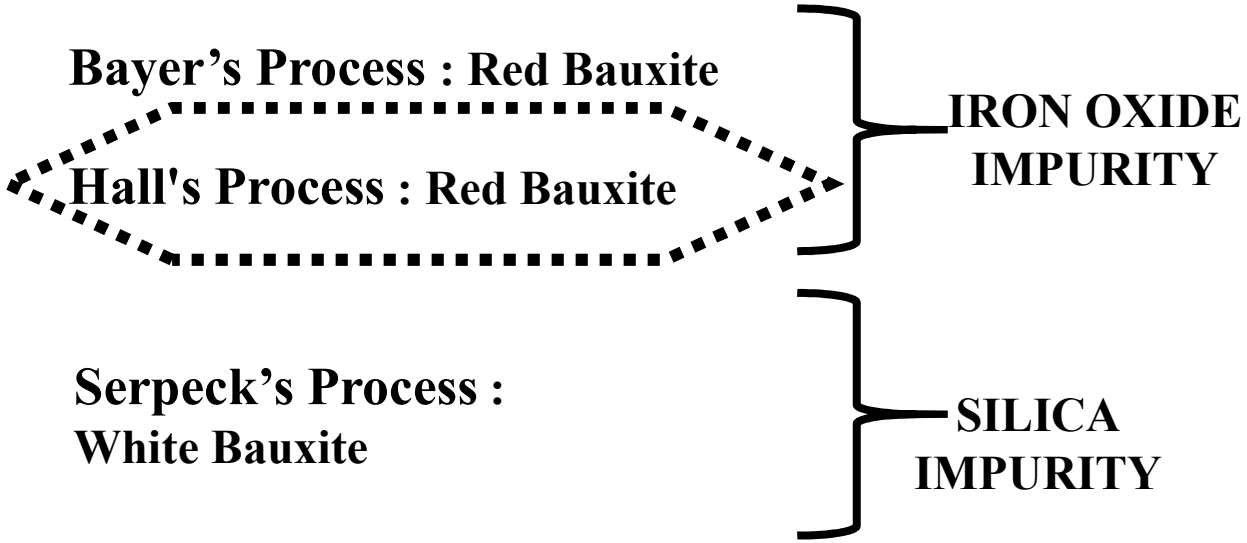
Minerals & ores of Aluminium



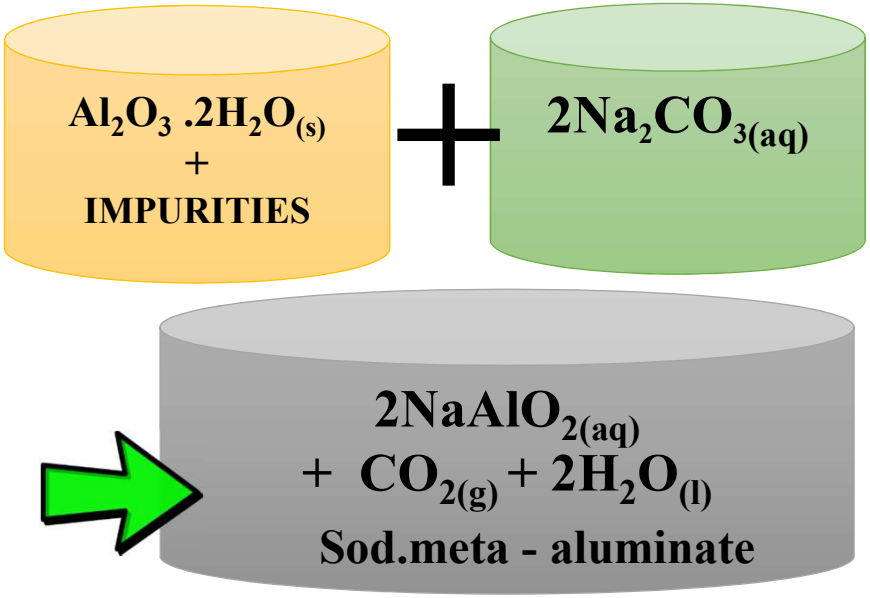
Extraction of Aluminium from bauxite

Step 1

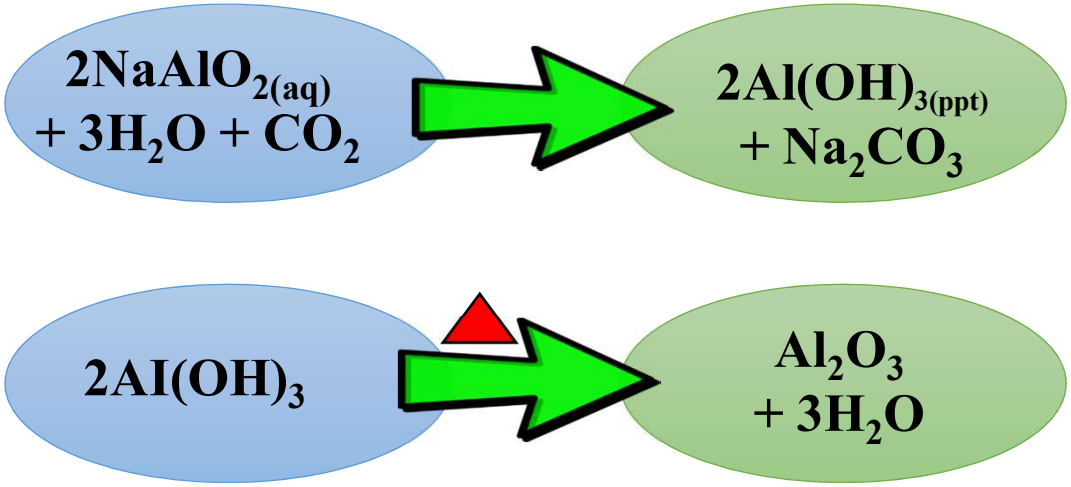
Concentration



Extraction of Aluminium from bauxite



Extraction of Aluminium from bauxite



Extraction of Aluminium from bauxite

Step 2

Extraction

a. Conversion of Ore into Oxide

b. Conversion of metal oxide into free metal (Reduction)

Aluminum is extracted by Electrometallurgy

Electrolysis of fused Alumina

(Hall and Heroult's process)

Hall and Heroult's process for Extraction of ALUMINIUM

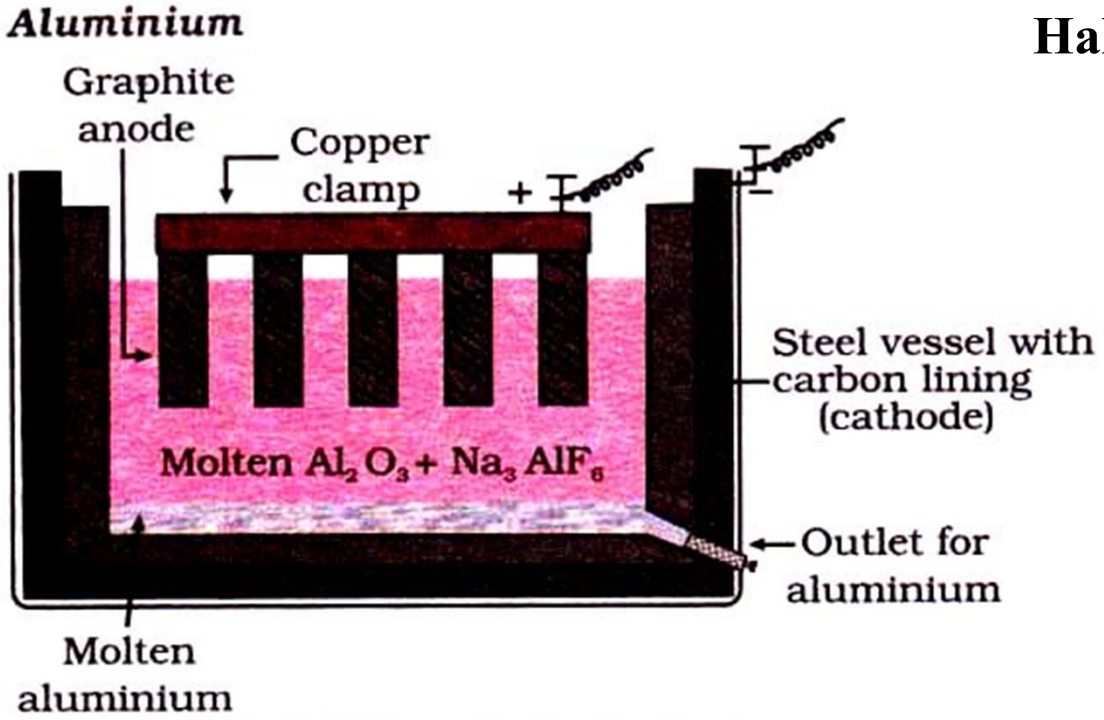


Fig. 5.6: *Electrolytic cell for the extraction of aluminium*

Hall and Heroult's process for Extraction of ALUMINIUM

Reactions during electrolysis

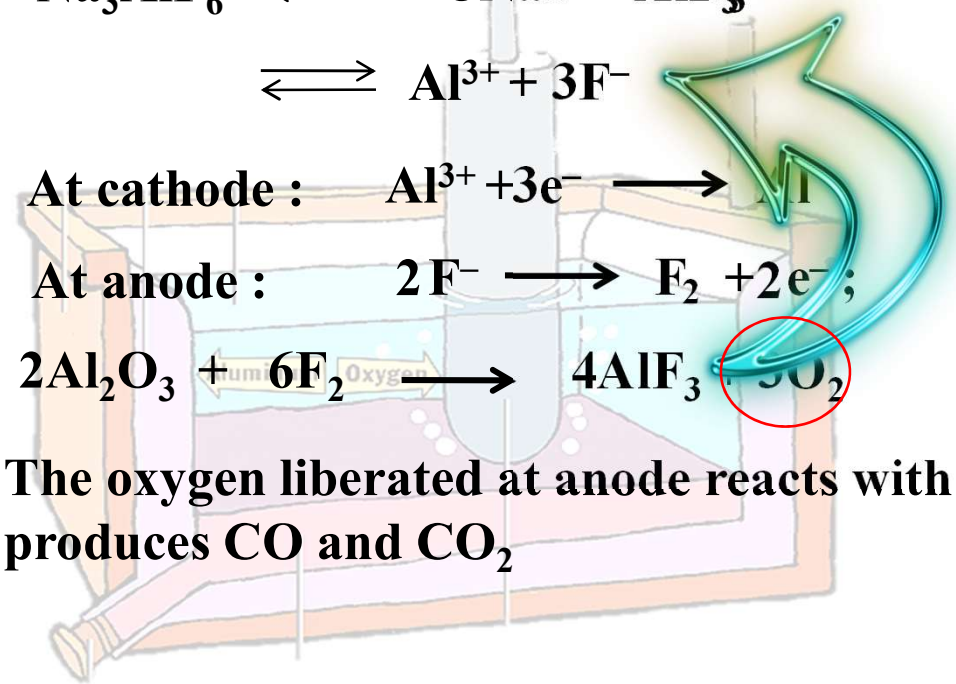
$Na_3AlF_6 \rightleftharpoons 3NaF + AlF_3$

$\rightleftharpoons Al^{3+} + 3F^-$

At cathode : $Al^{3+} + 3e^- \longrightarrow Al$

At anode : $2F^- \longrightarrow F_2 + 2e^-$;

$2Al_2O_3 + 6F_2 \longrightarrow 4AlF_3 + 3O_2$



The oxygen liberated at anode reacts with carbon of the anode and produces CO and CO_2

Drain plug

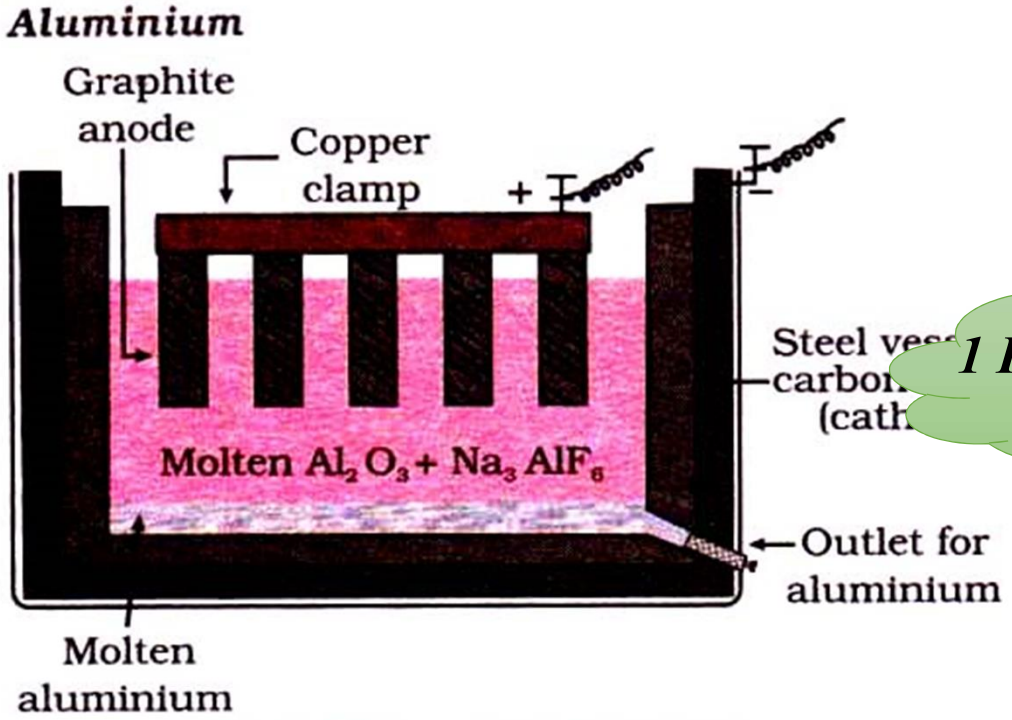


Fig. 5.6: *Electrolytic cell for the extraction of aluminium*

$$2\,C + O_2 \longrightarrow 2\,CO$$

$$2\,CO + O_2 \longrightarrow 2\,CO_2$$

1 Kg Aluminum is produced from 0.5 Kg carbon

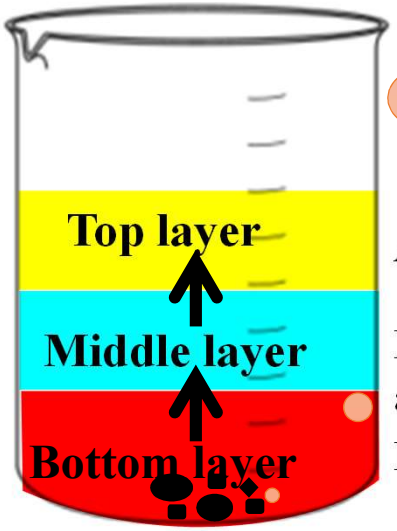
Extraction of Aluminium from bauxite

Step 2

Refining

Hoope's electrolytic process

Cell : 3 fused layers



Impurities remain at the bottom

Aluminium → Cathode

Mixture of Na_3AlF_6 and BaF_2 — Electrolytic Mixture

Impure Al → Anode

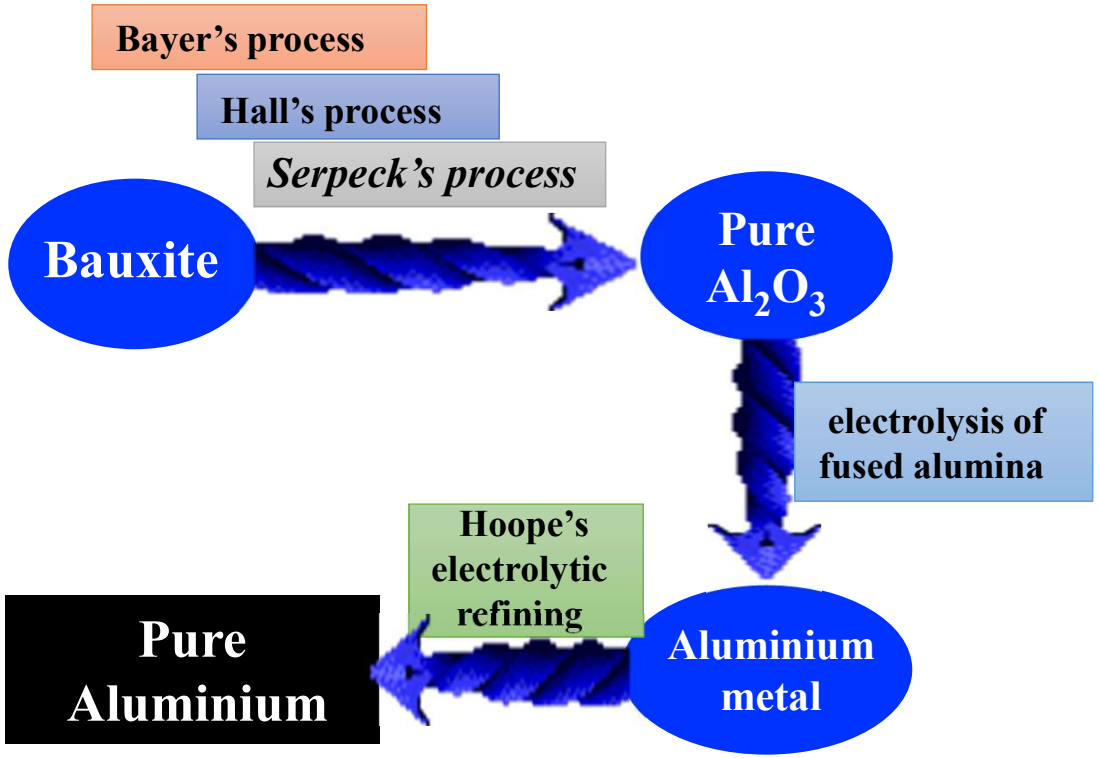
This is how bauxite looks like

The aluminium metal extracted is used for various reasons in our daily life

Interiors & Architecture purpose

Electronic devices & spare parts

Extraction of ALUMINIUM from Bauxite



Uses of aluminium

Most abundant metal on the earth

- **Foils**
- **Utensils, paints**
- **Making Alloys like Duraluminium**

MCQs

1) Which of the following method is not used for the concentration of Bauxite ore

a) Serpeck's method

b) Baeyer's method

c) ✓ Hoope's method

d) Hall's methode

2)The anode reaction in Hoope's process is

a) $Na+e- \rightarrow Na$

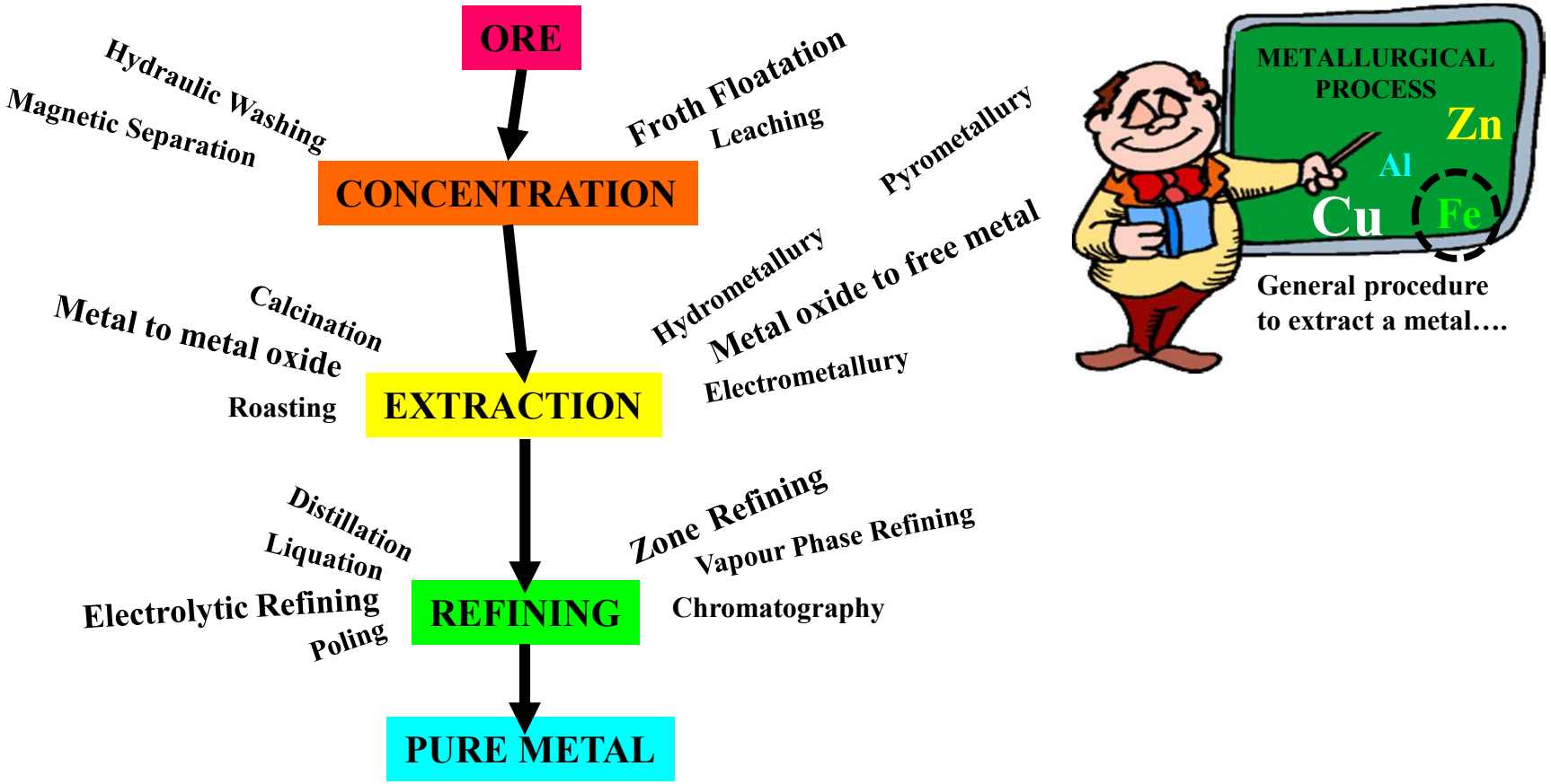
b) $Al^{3+} +3e- \rightarrow Al$

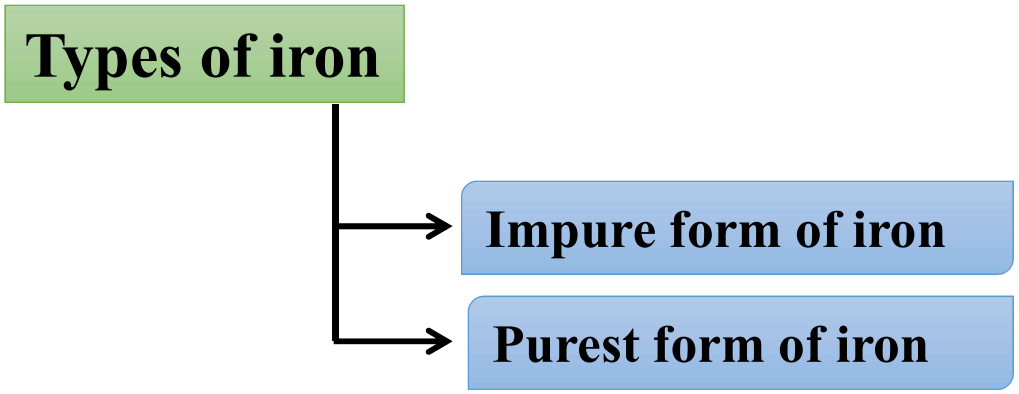
c) $Al \rightarrow Al^{3+} + 3e-$

d) $C+O_2 \rightarrow CO_2$

MINERALS & ORES OF IRON

1. EXTRACTION OF IRON FROM HAEMATITE


ORE
Hydraulic Washing
Magnetic Separation
Froth Floatation
Leaching
CONCENTRATION
Pyrometallury
Hydrometallury
Metal oxide to free metal
Electrometallury
Calcination
Metal to metal oxide
Roasting
EXTRACTION
Distillation
Liquation
Electrolytic Refining
Poling
Zone Refining
Vapour Phase Refining
Chromatography
REFINING
PURE METAL
METALLURGICAL PROCESS
Zn
Al
Cu
Fe
General procedure to extract a metal….


Types of iron
Impure form of iron
Purest form of iron

Types of iron

Impure form of iron

Cast Iron / Pig Iron

4% C

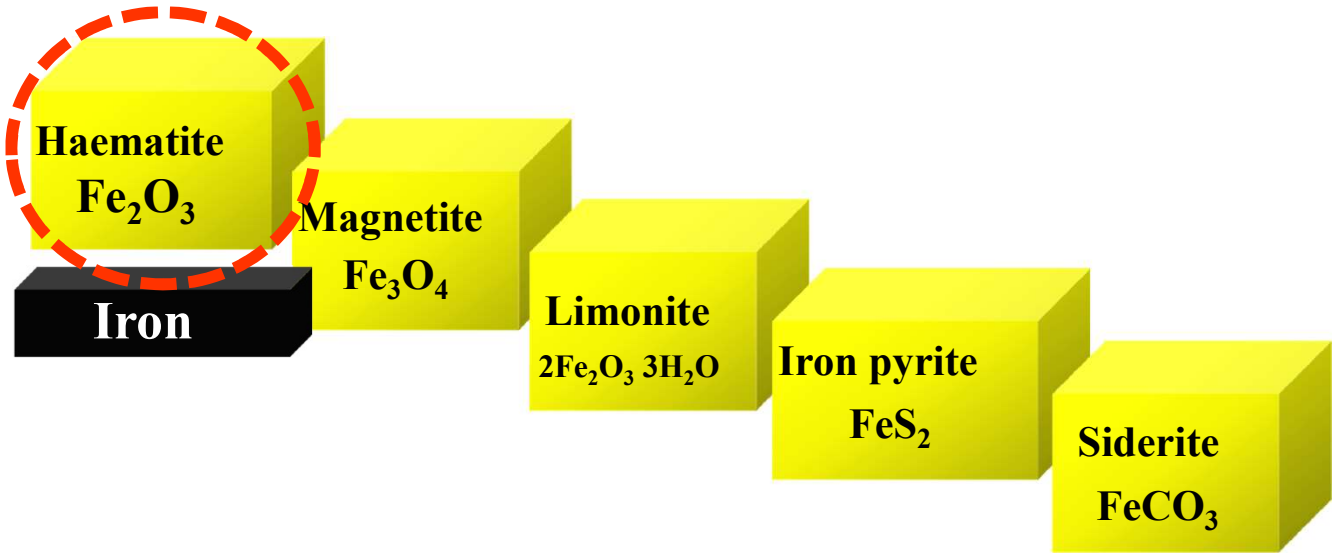
Hard, brittle

Types of iron

Purest form of iron

Wrought Iron	Steel
Less than 0.2% C	0.2% to 2%
Soft	Neither soft nor brittle

Minerals & ores of Iron



Extraction of iron from haematite

Step 1

Concentration

Hydraulic washing :: Removes lighter gangue particles

Extraction of iron from haematite

Step 2

Extraction

a. Conversion of Ore into Oxide ROASTING

In reverberatory furnace at 1200K

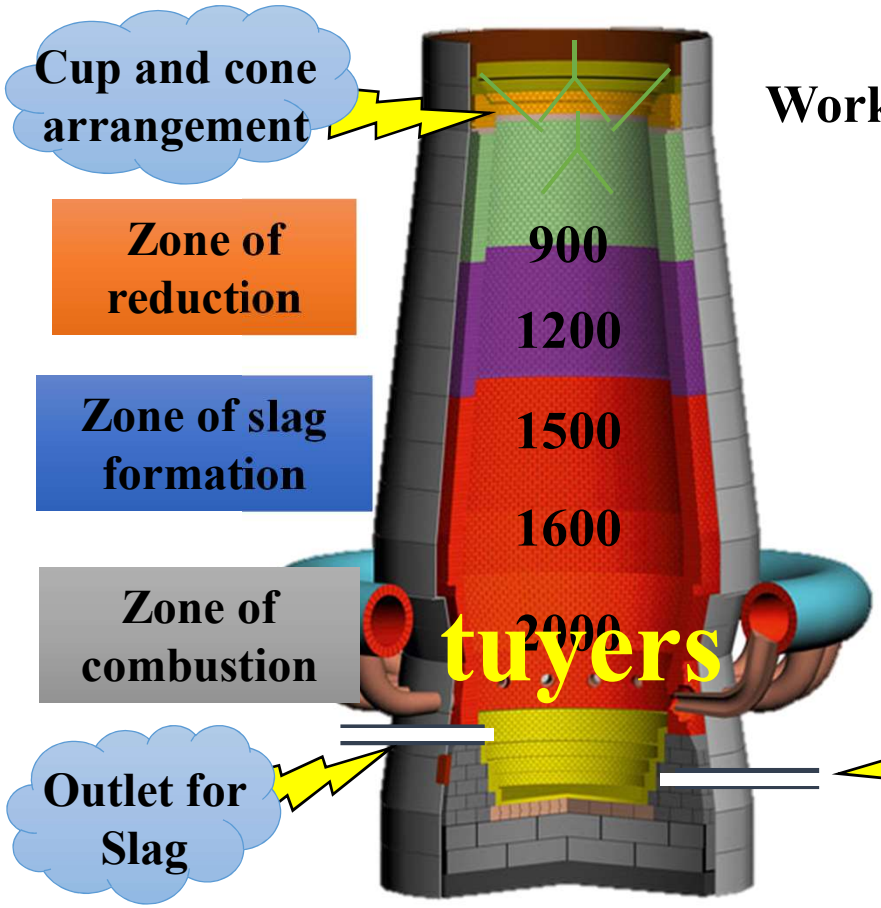
$$4\,FeO + O_2 \longrightarrow 2\,Fe_2O_3$$

Sulphur and Arsenic impurities are removed

b. Reduction of Oxide into Metal

Pyrometallurgy **smelting**

Reduction in Blast Furnace to obtain IRON METAL



$Fe_2O_3 + Coke + CaCO_3$

Working of Blast furnace

8 4 1

$Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

$CaCO_3 \longrightarrow CaO + CO_2$

$Fe_2O_3 + 3C \longrightarrow 2Fe + 3CO$

$CaO + SiO_2 \longrightarrow CaSiO_3$

$2C + O_2 \longrightarrow 2CO$

This is how haematite looks like

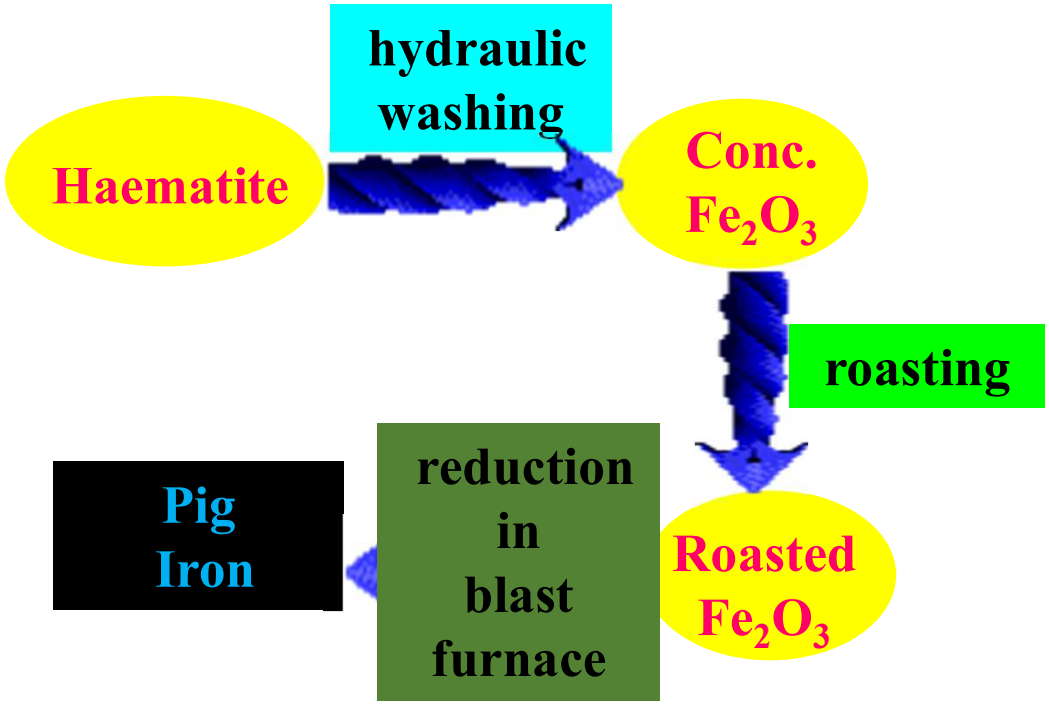
The iron metal extracted is used for various reasons in our daily life

Show pieces & furniture

Fencing , gates

Machinery , spareparts

Extraction of iron from haematite



Uses of iron

- **Railway Sleepers, Giant stoves**
- **Pipes, Construction Purposes**
- **Making Alloys like Steel**

MCQs

1) Which of the following is not an ore of iron?

a) Magnetite

b) Siderite

c) Calamine

d) Limonite

2) The % of carbon content in wrought iron is

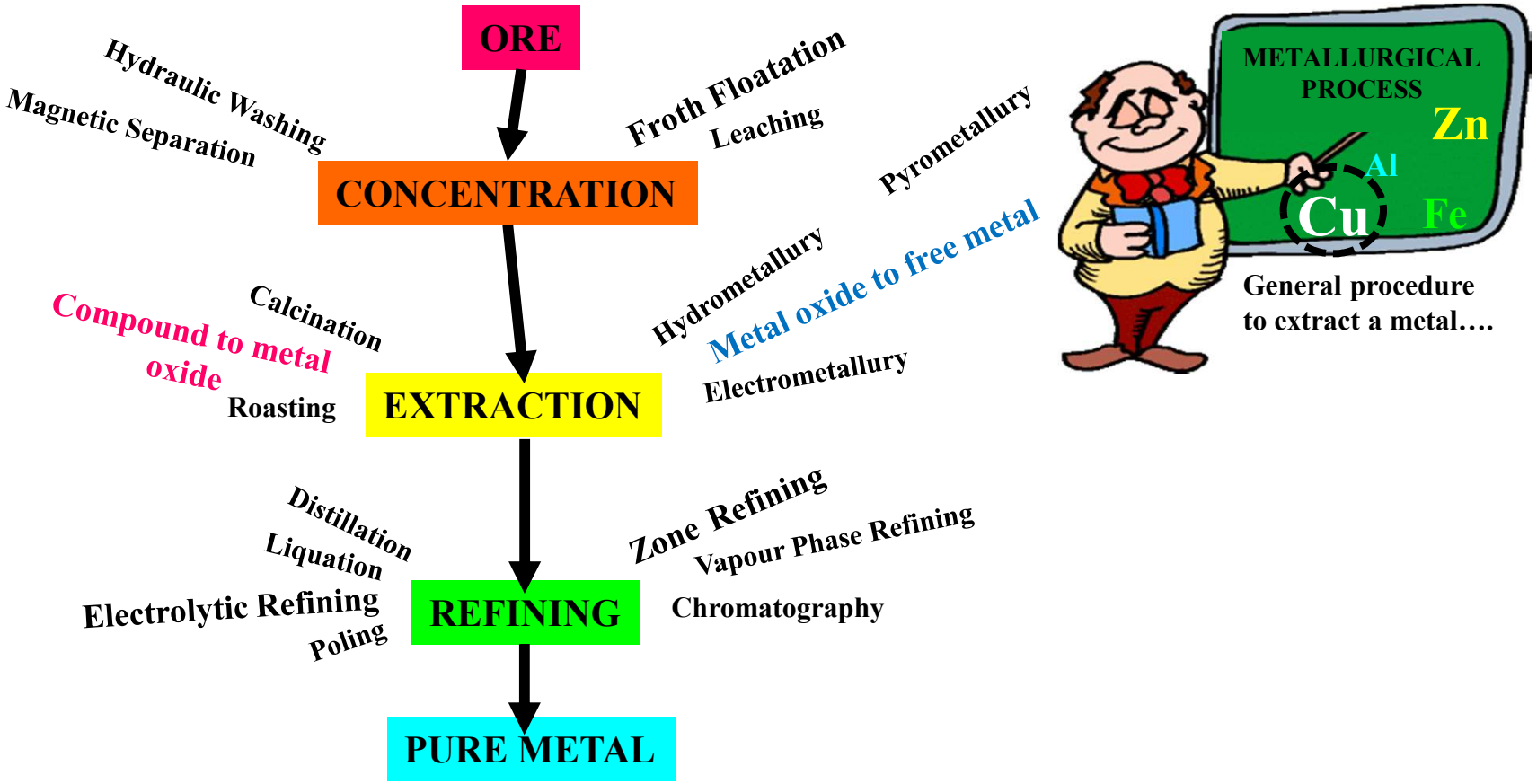
a) 0.2%

b) 3%

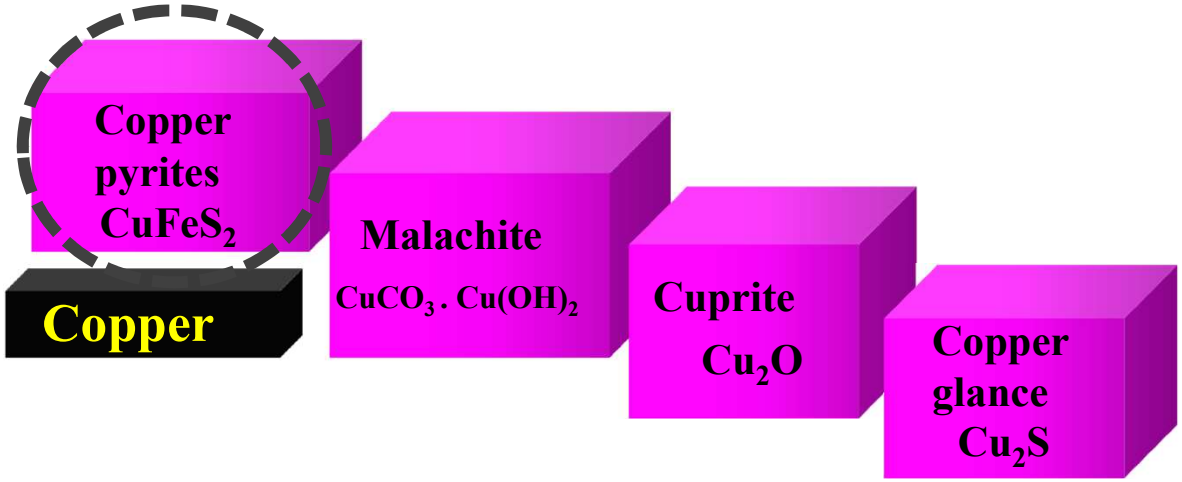
c) 0%

d) 1.5 to 2.5%

MINERALS & ORES OF IRON
1.EXTRACTION OF COPPER FROM COPPER PYRITES


ORE
Hydraulic Washing
Magnetic Separation
Froth Floatation
Leaching
CONCENTRATION
Pyrometallury
Hydrometallury
Metal oxide to free metal
Electrometallury
Calcination
Compound to metal oxide
Roasting
EXTRACTION
Distillation
Liquation
Electrolytic Refining
Poling
Zone Refining
Vapour Phase Refining
Chromatography
REFINING
PURE METAL
METALLURGICAL PROCESS
Zn
Al
Cu
Fe
General procedure to extract a metal….

Minerals & ores of Copper



Extraction of copper from copper pyrites

Step 1

Concentration

Froth Floatation Process ::

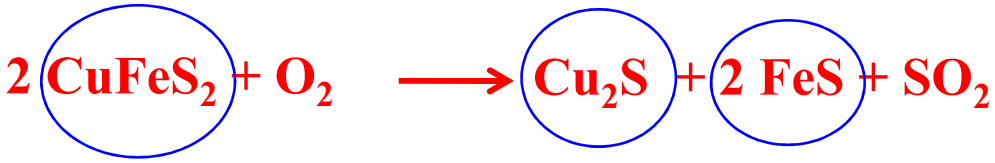
Because Copper Pyrite is a sulphide ore

Extraction of copper from copper pyrites

Step 2

Extraction

a. Conversion of Ore into Oxide by ROASTING



As and Sb ⟶ Removed in the form of volatile oxide

Extraction of copper from copper pyrites

Step 2

Extraction

b. Reduction of Oxide into Metal Pyrometallurgy i.e. smelting

Roasted ore + coke + sand → metal + slag+ oxide of carbon

$$2FeS + 3\,O_2 \longrightarrow 2\,FeO + 2\,SO_2$$

$$FeO + SiO_2 \longrightarrow FeSiO_3$$

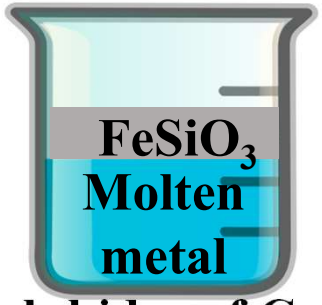
Basic Acidic (slag)

Impurity flux

Extraction of copper from copper pyrites

Step 2

Extraction



Sulphides of Cu^+, Fe^{2+}, coke, sand

Molten metal:

Extraction of copper from copper pyrites

Step 2

c. Bessemer

Matte is transferred ⟵

$2\ Cu_2S + 3\ O_2 \longrightarrow 2\ Cu_2O + 2\ S$

$2\ Cu_2O + Cu_2S \longrightarrow 6\ Cu + SO_2$

↓

Poured into sand moulds → **SO_2 escapes**

↓

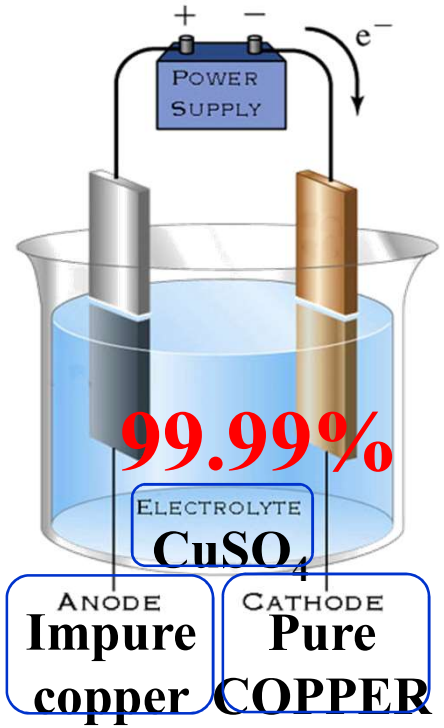
Leaves blister on surface

⟸ **Blister Copper 99% pure**

Extraction of copper from copper pyrites

Step 3

Refining



Electrolytic refining

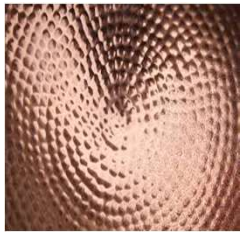
Impurities : Ag and Au

This is how copper pyrite (chalco pyrite) looks like

The copper metal extracted is used for various reasons in our daily life

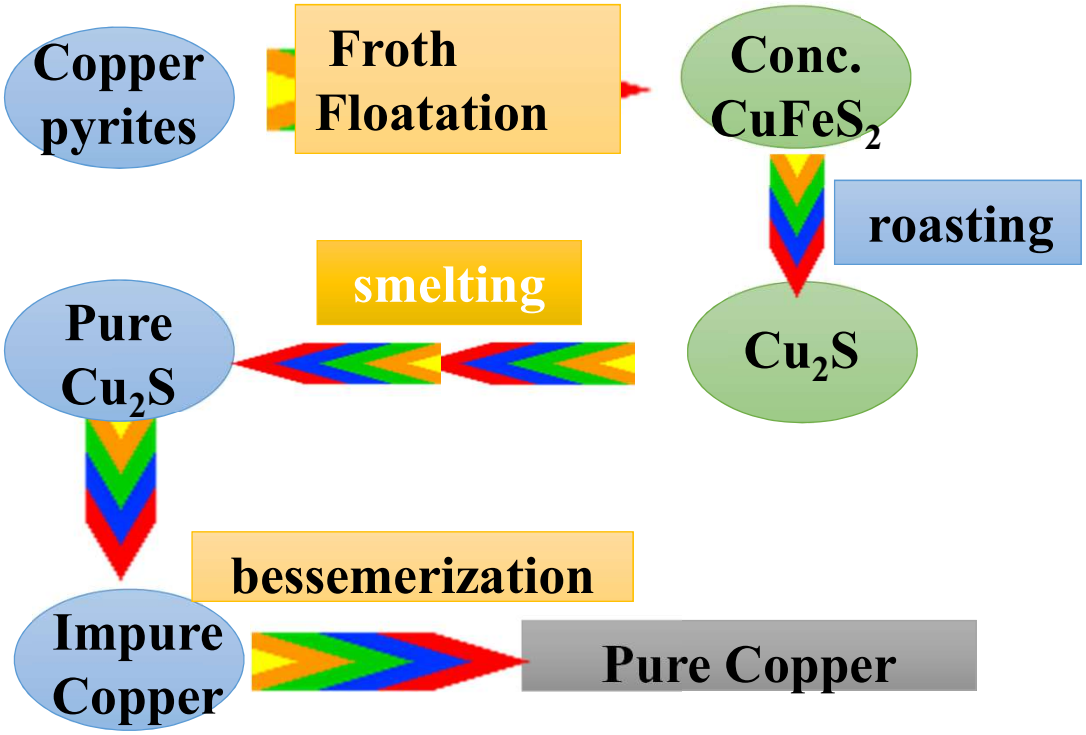
ornaments

coins



In interiors

Extraction of copper from copper pyrites



Uses of copper

- **Electrical Equipment**
- **Vessels**
- **Ornaments**

MCQs

1) The copper metal is extracted from its

a) Carbonate ore

b) Sulphide ore ✔

c) Sulphate ore

d) Chloride ore

2) The bessimerization of copper gives

a) Impure metal

b) 99% pure metal ✔

c) Copper oxide

d) Copper nitrate.

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