* SHORT NOTES OF METALLURGY *

① Mineral → found in side earth crust → must contain metal

② Ore → mineral → must contain high % of metal
All ores are minerals → true
All minerals are ores → false

③ Gangue → impurities → matrix

Sulphide ore :→

I C → iron pyrite → FeS_2
C → copper pyrite → $CuFeS_2$
S C → Silver glance → Ag_2S
C → Copper glance → Cu_2S
Zinc → Zinc blonde → ZnS

Gayg → Galena → pbs
Cinema → Cinnabar → HgS

Oxide ore :→

Hamatite Fe_2O_3 हेमा
Limonite $2Fe_2O_3.3H_2O$ लिमो
magnetite Fe_3O_4 माँ
pyrolusite MnO_2 पारो
Bauxite $Al_2O_3.2H_2O$ Box
cassetnite SnO_2 cassetle
Lithargic PbO_2 Lithargic
cupsite Cu_2O Ruby copper
ZnO zincite philsopher
correndum Al_2O_3

Carbonate ore :→

Calamine $ZnCO_3$
Malachite $CuCO_3.Cu(OH)_2$
Azurite $2CuCO_3.Cu(OH)_2$
Siderite $FeCO_3$
Limestone $CaCO_3$
Magnesite $MgCO_3$
dolomite $MgCO_3.CaCO_3$
Cerrusite $PbCO_3$

Epsum :→
$MgCO_3.7H_2O$

Halide ore :→
Florospaz → CaF_2
Horn Silver → $AgCl$
Cryolite → Na_3AlF_6
Kernalite → $KCl.MgCl_2.6H_2O$

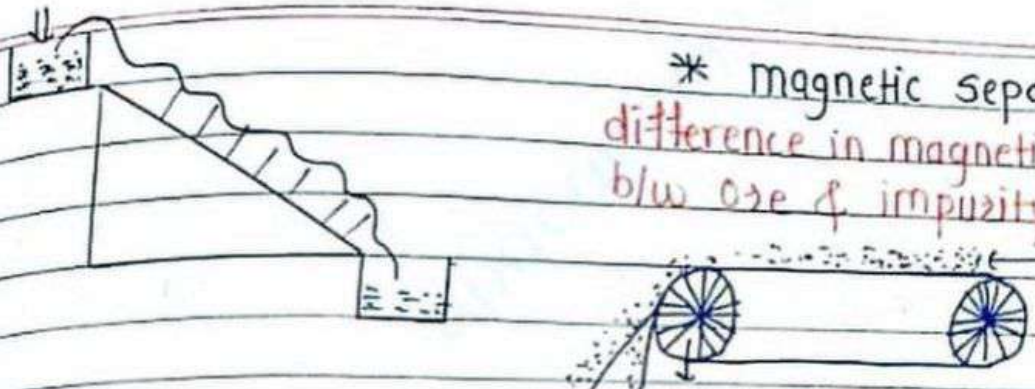
Metallurgy → ore → metal

4 steps

① concentration of ore → Gravity separation, magnetic separation, Froth floatation, leaching
② Ore → oxide → Calcination, Roasting
③ oxide → (Reduces) metal → Ellingham diagram, Reactivity series / Pyrometallurgy, Self Reduction, Electron metallurgy
④ Refining
(1) polling
(2) distillation
(3) liquation
(4) Cupelation
(5) Bessimerization
(6) Zone refinning
(7) mond's process
(8) Van Arkel process
(9) Electrolytic Refining

Hammering
Crushing
grinding

* Gravity Separation :→
difference in density of ore & impurity
Fe_2O_3
Hydrolytic washing
levigation



* magnetic separation
difference in magnetic character b/w ore & impurity

powdered ore

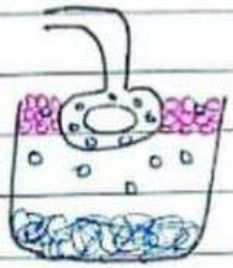
magnetic wheels

impure ← non-magnetic

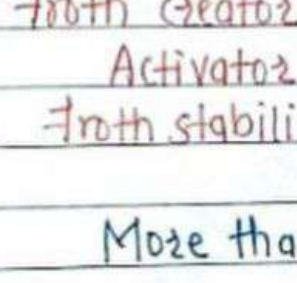
pure magnetic

Eg :→ SnO_2 → Cassiterite
Tinstone
impurity [$FeWO_4$ + $MnWO_4$
Wolframite

* Froth Floatation (झाग तैरना)
# sulphide ore
difference in wettability
ore → oil
impure → water



ZnS
$CuFeS_2$
Cu_2S
PbS



coordinate bond with metal of sulphide ore

Froth creator :→ Pine oil, camphor oil
Activator :→ sodium ethyl xanthate
Froth stabilizer :→ phenol, cresol, Aniline

More than one sulphide ore

$Zn + PbS \xrightarrow[NaCN]{\text{Depressent}} Na_2[Zn(CN)_4]$

↓ oxidizing
↓ $CuSO_4$ (Activator)

ZnS

* Leaching
↳ Bauxite

$Al_2O_3 + NaOH \longrightarrow NaAlO_2 + H_2O$
ore Solvent

$Na[Al(OH)_4] \xrightarrow{CO_2} Al_2O_3.XH_2O + NaHCO_3$

↓ Δ

Al_2O_3

① Soluble
② Suitable Reagent

Extraction of Ag, Au

Cyanide process

$Ag + KCN + O_2 + H_2O \longrightarrow K[Ag(CN)_2] + KOH + K_2S$

$K[Ag(CN)_2] + Zn \longrightarrow Ag + K_2[Zn(CN)_4]$

Mac Auzth process

$Au + KCN + O_2 + H_2O \longrightarrow K[Au(CN)_2] + K$

$K[Au(CN)_2] + Zn \longrightarrow Au + K_2[Zn(CN)_4]_2$

Calcination	Roasting
* Heating * absence of air * below MP	* Heating * Limited supply of air * below MP
Carbonate CO_3 oxide O_2 Hydrated oxide H_2O hydroxide OH	Sulphide ore $PbS + O_2 \longrightarrow PbO + SO_2$ $Cu_2S + O_2 \rightarrow Cu_2O + SO_2$

$Al_2O_3 \cdot 2H_2O \xrightarrow{\Delta} Al_2O_3 + H_2O$

$Fe_2O_3 \cdot 2H_2O \xrightarrow{\Delta} Fe_2O_3 + Fe_2O$

$Al(OH)_3 \xrightarrow{\Delta} Al_2O_3 + H_2O$

$ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$

$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

REVERBERATORY FURNACE

Flux & Slag

Flux + infusible impurity (which can't melt) → Slag (It floats over liq metal) + fusible impurity

- Acidic flux
  - ↳ React Basic impurity
  - $FeO + SiO_2 \rightarrow FeSiO_3$
  - Basic impurity
- Basic flux
  - ↳ React with acidic impurity
  - $SiO_2 + CaCO_3 \rightarrow CaSiO_3$
  - Acidic impurity

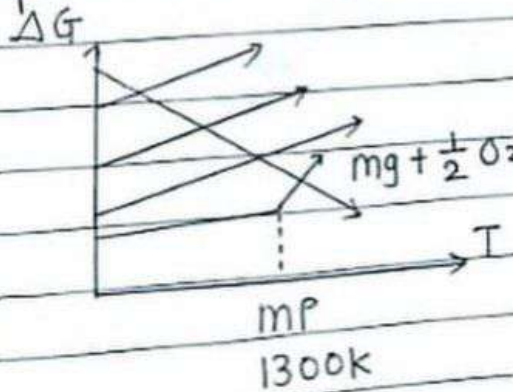
Ellingham diagram $\Delta G = \Delta H - T\Delta S$

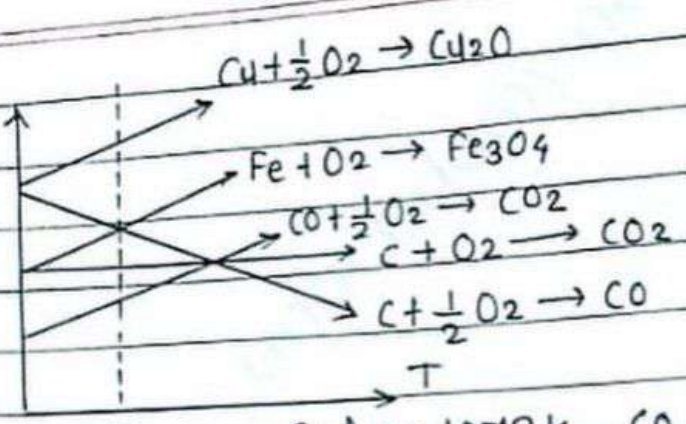
Plot b/w ΔG (y axis) and T (x axis)

Line 1 :→ lower line can reduce upper metal oxide

Line 2 :→ more lower the line is more better is the reducing agent

Line 3 :→ sharp turn / sudden ⇒ Melting point





Before 1073K, CO is a good reducing agent

After 1073, CO is good reducing agent

Pyrometallurgy

High reactive

Please	potasium
Stop	sodium
Calling	calcium
me	magnesium
a	Aluminium

Smelting ↓ Reduction with carbon

cute	carbon
Zebra	Zinc
I	Iron
never	nickel
today	Tin
like	lead
her	Hydrogen
call	copper
smart	silver
goat	gold
poor	platinum

$Ag_2O \xrightarrow{\Delta} Ag + \frac{1}{2}O_2$

$Au_2O \xrightarrow{\Delta} Au + \frac{1}{2}O_2$

$PtO \xrightarrow{\Delta} Pt + \frac{1}{2}O_2$

Reduction of metal oxide by more electropositive metals

① Aluminium thermite process

$Cr_2O_3 + Al \rightarrow Al_2O_3 + Cr$

$Fe_2O_3 + Al \rightarrow Al_2O_3 + Fe$

Railway track welding

② Croll's process :-

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

Copper

$CuFeS_2$ → Froth Floatation → Roasting → Self Reduction
↳ (C4) Bessemarization

Extraction of Aluminium

$Al_2O_3.2H_2O$ → leaching → calcination → Refining → Electrometallurgy

① Iron impurity → Bayer's → $Al_2O_3 + NaOH \rightarrow NaAlO_2 + H_2O \rightarrow Al(OH)_3 \xrightarrow{\Delta} Al_2O_3$

② SiO_2 impurity → Serpeck → $Al_2O_3 + N_2 \rightarrow AlN + H_2O$

③ Iron + SiO_2 impurity
↳ Halls $Al_2O_3 + Na_2CO_3 \rightarrow NaAlO_2 + H_2O$ → $Al(OH)_3 + NH_3 \xrightarrow{\Delta} Al_2O_3$

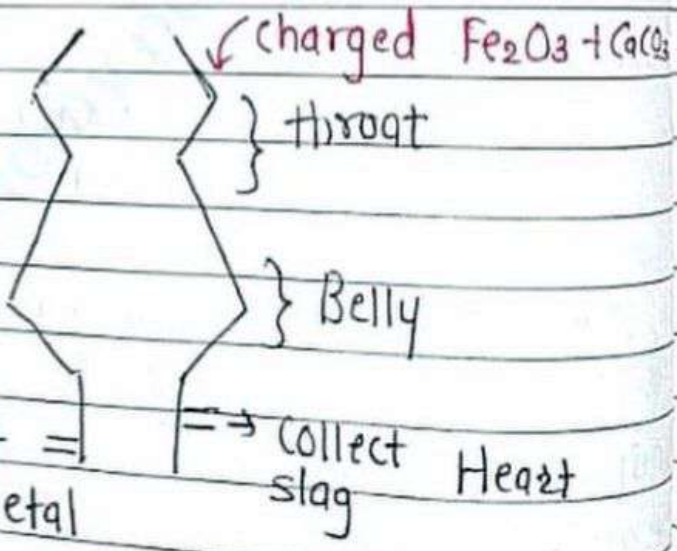
$AlCO_4 \xrightarrow{\Delta} Al_2O_3$

Electrolytic Refining

- Cathode → Steel
  Anode → Graphite
  Electrolyte → Koi bhi sol^n salt

Metallurgy of Iron

↳ Blast Furnace



① Combustion zone 1500 - 1600 °C
② Reduction zone 800 - 700 °C
③ Slag formation zone 800 - 1000 °C
④ Fusion zone 1200 - 1500 °C

① Combustion zone
$E + O_2 \rightarrow CO_2 + heat$
$CO_2 + C \rightarrow CO$

② Reduction zone
$Fe_2O_3 + CO \rightarrow Fe_3O_4$
$Fe_3O_4 \rightarrow FeO + IO \rightarrow Fe$

③ Slag formation zone
$CaCO_3 \rightarrow Ca + CO_2$
$CaO + SiO_2 \rightarrow CaSiO_3$

④ Fusion zone
$Fe(s) \xrightarrow{\Delta} Fe(l)$

Self Reduction :→

$PbS + O_2 \rightarrow PbO + SO_2$

$PbO + PbS \rightarrow Pb + SO_2$

$Cu_2S + O_2 \rightarrow Cu_2O + SO_2$

$Cu_2O + Cu_2S \rightarrow Cu + SO$

Blister copper ⇐ due to → Please of SO_2

Refining

① Polling ⇒ large container + fresh woodenlog cut + Hydrocarbon gas

→ Reducing agent Cu, Sn

② Distillation ⇒ B.P low → Zn, Cd, Hg

③ Liquation ⇒ MP low → Volatile → Sn, Pb, Bi

④ Cupelation ⇒ when a metal impurity is present in other noble metal → Ag, Au, Pt

Agoze + $O_2 \rightarrow Ag_2O + PbO$ ↓Δ

Pb impurity Ag

⑤ Bessemerzation ⇒ Blister copper → auto reduction self reduction

Cu_2S (Fe impurity) + $O_2 \rightarrow Cu_2O + SO_2$

$Cu_2O + Cu_2S \rightarrow \underline{Cu} + SO_2$ B. Copper

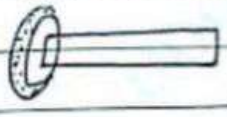
$FeS + O_2 \rightarrow FeO + SO_2$

$FeO + SiO_2 \rightarrow FeSiO_3$

⑥ Zone refining ⇒ semiconductor

↓

Principle :→ impurities are more soluble in molten state



⑦ Mond's process ⇒ Mo, Ni, Co → $Ni + Co \rightarrow \underset{\text{volatile}}{Ni(CO)_4} \xrightarrow{\Delta} Ni + Co$

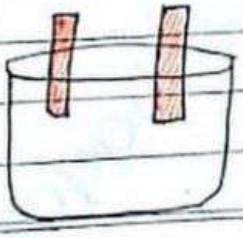
⑧ Van Arkel process ⇒ Ti Zr $Ti + I_2 \rightarrow TiI_4 \xrightarrow{\Delta} Ti + 2I_2$

Silver Refining → Electrometallurgy

Cathode → Pure & पतला Ag

Anode → Impure & मोटा Ag

electrolyte → $AgNO_3$



remelting with scrap iron
- Pig iron → C → 5% Hard & brittle
- Cast iron → C → 2.5 - 5%
- Wrough iron → C → 0.2% → Purest iron

Alloy of iron → Steel
↳ Fe + C → 0.2% - 5%