UDAAN

2025

Bharat Mata Ki Jai ♡

METALS AND NON-METALS

(Occurrence and Extraction of Metals (Metallurgy) – Part III)

CHEMISTRY | Lecture - 08

BY: SUNIL BHAIYA

Topics

to be covered

1. Extraction of Metals of Medium Reactivity
2. Extraction of Metals of High Reactivity


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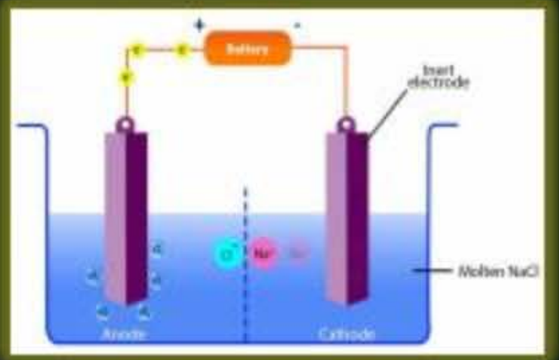
Knowledge Ride On

Extraction of Metals of Medium Reactivity

Knowledge Ride On



Extraction of Metals of High Reactivity

Knowledge Ride On

Insaniyat Ka Gyaan

RIDDLE WALLAH

Can you name a movie that has stars Anil Kapoor and Madhuri Dixit and the name is formed from the chemical symbols of beryllium and tantalum?

Be

Ta

BeTa

RIDDLE WALLAH

Can you name a movie that has stars Anil Kapoor and Madhuri Dixit and the name is formed from the chemical symbols of beryllium and tantalum?

Udaanians be like - - - - - - - →

Extraction of Metals of Medium Reactivity

Step III: Extraction of Metals From Concentrated Ore (Metals of Medium Reactivity)

C-I

Zn, Fe and Pb are metals of medium reactivity which are found in the form of their oxides, sulphides or carbonates.

C-II

Will the first two steps be the same in this case as well?

A. Yes

B. No

Step Ist → Crushing & Grinding of Ore

Step IInd → Concentration of Ore

Step III: Extraction of Metals From Concentrated Ore (Metals of Medium Reactivity)

Zn, Fe and Pb are metals of medium reactivity which are found in the form of their oxides, sulphides or carbonates.

Ab btao sulphide (metal) or carbonate (metal) ko phle oxide (metal) bnaenge ya nhi?

A. Yes

B. No

Extraction of Metals of Medium Reactivity

Thermal Decomposition

Roasting	Calcination
(i) Used for **sulphide ore**.	(i) Used for **carbonate ore**.
(ii) **Sulphide ore** is strongly heated in excess of air below the melting point of metal. (Oxygen, 20.95 v.)	(ii) **Carbonate ore** is strongly heated in absence of air below the melting point of metal.
(iii) **Metal sulphide + Oxygen -> Metal oxide + Sulphur dioxide gas**	(iii) **Metal carbonate $\xrightarrow{\Delta}$ Metal oxide + Carbon dioxide gas**
(iv) **Sulphur dioxide gas** is evolved.	(iv) **Carbon dioxide gas** is evolved.

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Extraction of Metals of Medium Reactivity – Zinc (Zn)

Step 1st & 2nd → same

Let's analyse the case of zinc!

Ore → Zinc blende (ZnS)

Step 3rd

Roasting

$$2ZnS(s) + 3O_2(g) \xrightarrow{\Delta} 2ZnO(s) + 2SO_2(g)$$

Extraction of Metals of Medium Reactivity – Zinc (Zn)

Step I & IInd → 'same'

Let's analyse the case of zinc!

Ore → Calamine ($ZnCO_3$)

Step IIIrd

Calcination

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

Extraction of Metals of Medium Reactivity

After roasting or calcination we get metal oxide. Now, what next?!

→ Addition of hydrogen
→ Removal of oxygen
→ Both

Reduction of metal oxide to metal

Reducing agents like carbon, aluminium etc. are used.

(दंडा) (बंदूक)

Extraction of Metals of Medium Reactivity – (Zn)

Step IVth Reduction of metal oxide by carbon (coke) - *Smelting* (Smelter)

① porous (containing holes) & amorphous (no fixed geometrical shape) ② economical & easily available

$$ZnO(s) + \underset{(coke)}{C(s)} \xrightarrow{heat} Zn(l) + CO(\uparrow)$$

further acts as reducing agent

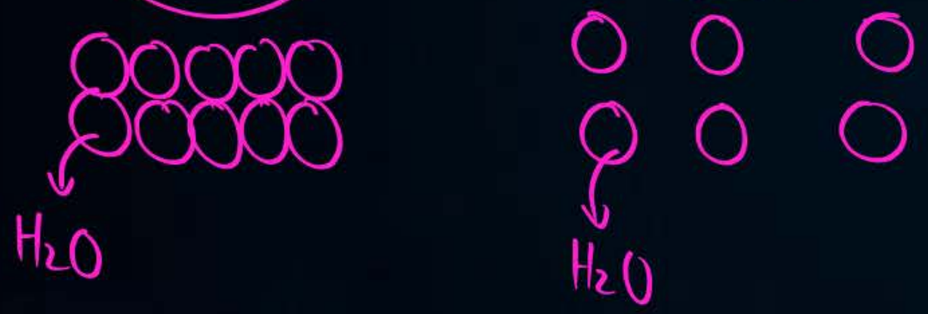
$$ZnO(s) + CO(g) \longrightarrow Zn(l) + CO_2(\uparrow)$$

Melting

(I) Physical change

(II) Ice (solid) $\xrightarrow{\text{heat}}$ Water (liquid)

$H_2O(s) \xrightarrow{\text{heat}} H_2O(l)$



Smelting

(I) Chemical change

(II) Metal oxide + Coke $\xrightarrow{\Delta}$ Metal + Carbon monoxide

Metal → molten/fused state

Extracting metal (Fe) from Fe_2O_3 requires calcination or roasting!

(A) Yes

(B) No

roasting: metal sulphide → metal oxide

calcination: metal carbonate → metal oxide

Extraction of Metals of Medium Reactivity

(K) for metals above Zn in reactivity series!

Reduction of metal oxide by aluminium - *Aluminothermy*

Removal of oxygen – REDUCTION – OXIDANT

MnO_2 ⇓ Pyrolusite

$$3MnO_2(s) + 4Al(s) \longrightarrow 3Mn(l) + 2Al_2O_3(s) + heat$$

S.B. S.K. — Bandook

because of this

Addition of oxygen ↓ OXIDATION ↳ Reductant

(I) Displacement rxn

(II) Redox rxn

(III) Exothermic rxn

Give a Thought

Why carbon is not used in case of Mn?

(as reducing agent)

Give a Thought

Why carbon is not used in case of Mn?

↳(as reducing agent)

Aluminium is more reactive than Mn. It means it can easily displace them and forms aluminium oxide. Doing the same cannot be satisfactorily done with carbon.

Imp.

Can Fe_2O_3 be reduced by carbon (coke) ?

⟹ Yes, metals like Zn & below it can easily be reduced by carbon (C).

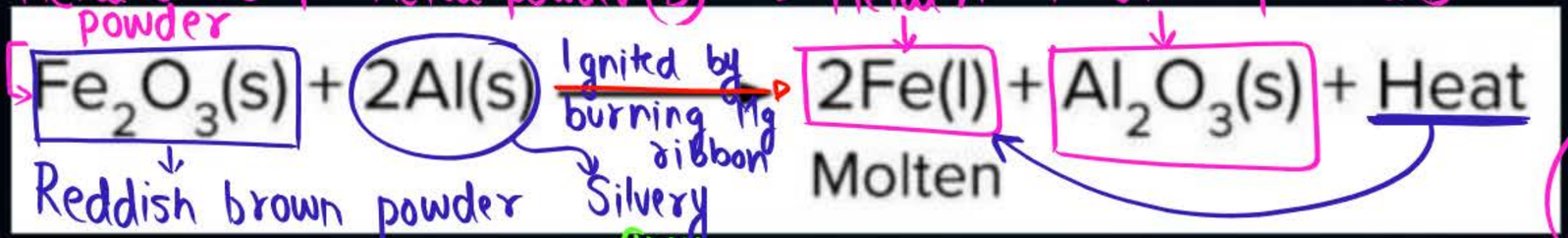
Extraction of Metals of Medium Reactivity

Reduction of metal oxide by aluminium - *Aluminothermy*

(Type of Thermite Rxn)

'application'

(A)
Metal oxide + Metal powder (B) ⟶ Metal A + Oxide of metal B



Why world Thermite ?
↓
extreme heat is released

Reactivity of Al > Fe

The reaction is therefore used for welding the broken parts of *iron machinery, railway tracks* etc. The reaction is known as thermite reaction.

Thermite reaction is a type of *displacement*, *exothermic and redox reaction*.

Summary of All Steps – Metals of ~~Low~~ Medium Reactivity

Step I
Crushing and Grinding of Ore

Powdered ore

Step II
Concentration of Ore

Concentrated ore →

Step III
Roasting (Sulphide Ore)

(Oxide Ore)

Step III
Calcination (Carbonate Ore)

Metal oxide

Step IV
Reduction to metal oxide to metal (Using reducing agent)

Using Coke (C) (SMELTING)

Using Al (ALUMINOTHERMY)

Step V
Refining/Purification of metal

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Extraction of Metals of High Reactivity – Part I

Extraction of Metals of High Reactivity

K, Na, Ca, Mg and Al are metals of high reactivity. Let's discuss how they are extracted from halides or oxides.

Chlorides

Ore

Sodium → Rock salt ($NaCl$)

Aluminium → Bauxite ($Al_2O_3.2H_2O$) or (Al_2O_3)

Q1 Is it required to use calcination or roasting for chlorides or oxides of metals of high reactivity ?

NO

Extraction of Metals of High Reactivity

After concentration of ore, can we use reduction of metal oxide through reducing agents like carbon?

or aluminium

No

chlorides

The oxides/~~halides~~ of highly reactive metals are quite stable, cannot be reduced by any reducing agent. They have more affinity for oxygen/~~halogen~~. Chlorine.

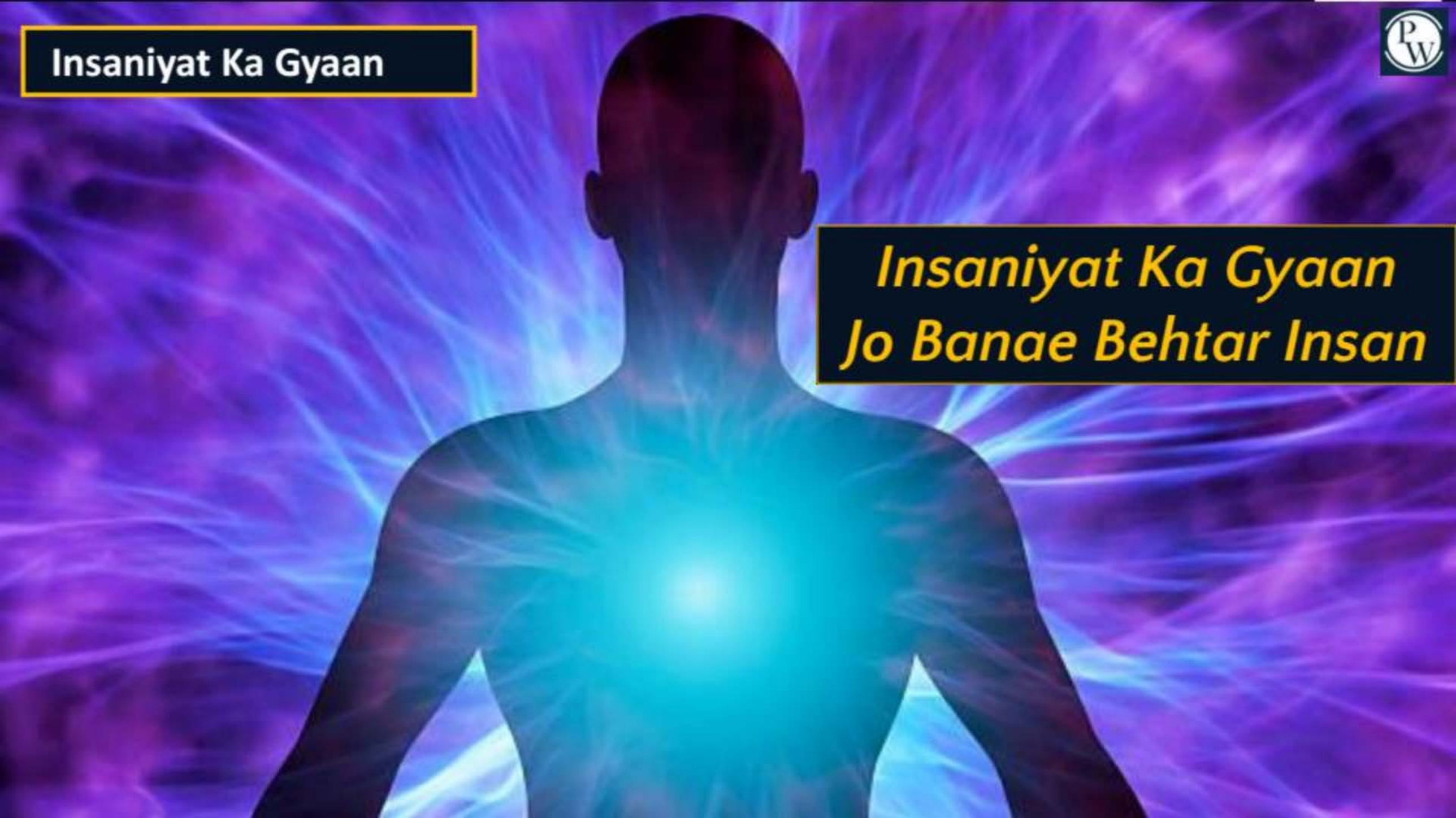
Extraction of Metals of High Reactivity

A special reduction process, i.e. electrolytic reduction is used for highly reactive metals like K, Na, Ca, Mg and Al.

Electrolytic Reduction

Concept Polish (गृहकार्य)

NO HOMEWORK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THANK YOU