

Aluminium



Q. What are the ores of Aluminium? How is Aluminium extracted from its main ore and refined? Discuss the action of Aluminium with ① air ② water ③ with HCl ④ NaOH ⑤ Cl_2 Giving the conditions mention the uses of aluminium.

Q.2 Write notes on ① Goldschmidt-alumino-thermic process. ② Alumina ③ Anhydrous (Al_2O_3) ④ Alums ⑤ Potas alum. ⑥ One dry test and one wet test of aluminium salt. in salt test.

Ans

Ores of Aluminium :- ① Bauxite ($Al_2O_3 \cdot 2H_2O$) - the main ore.

② Cryolite ($AlF_3 \cdot 3NaF$) found in Greenland only.

③ Spinel ($Al_2O_3 \cdot MgO$).

Metallurgy

1. Concentration

(a) Bayer's process.

(b) Hall's process.

(c) Serpek process.

2. Electrolysis of

Alumina (Al_2O_3)

3. Purification of the metal.

1. Concentration

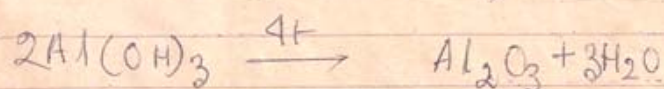
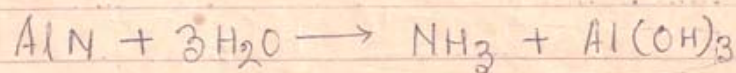
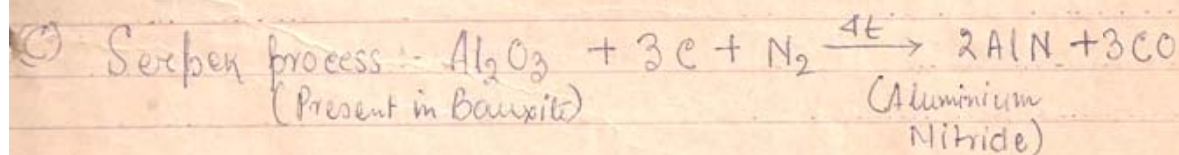
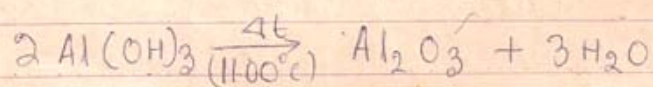
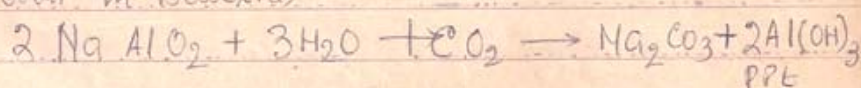
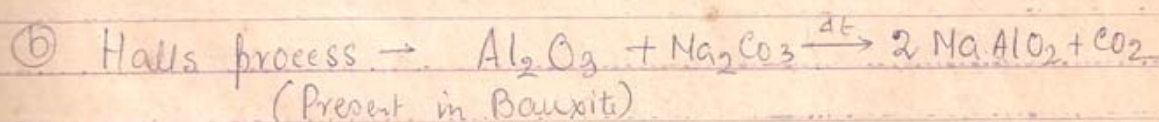
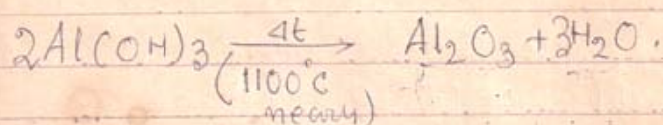
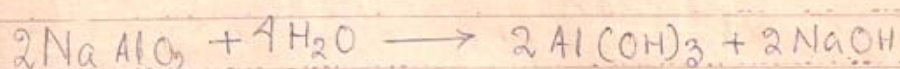
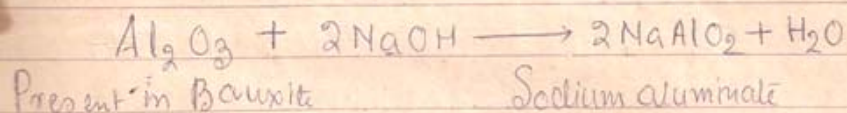
(a) Bayer's process :- The ore is broken into pieces and then crushed into a fine powder and then digested with NaOH solution having sp. gravity 1.45, in an autoclave (similar to pressure cooker) nearly for eight hours under eighty pound pressure at $150^\circ C$. The ore bauxite reacts with NaOH forming sodium aluminate (soluble). Only iron oxide and sand remain as impurity and is called "Red mud".

Aluminium

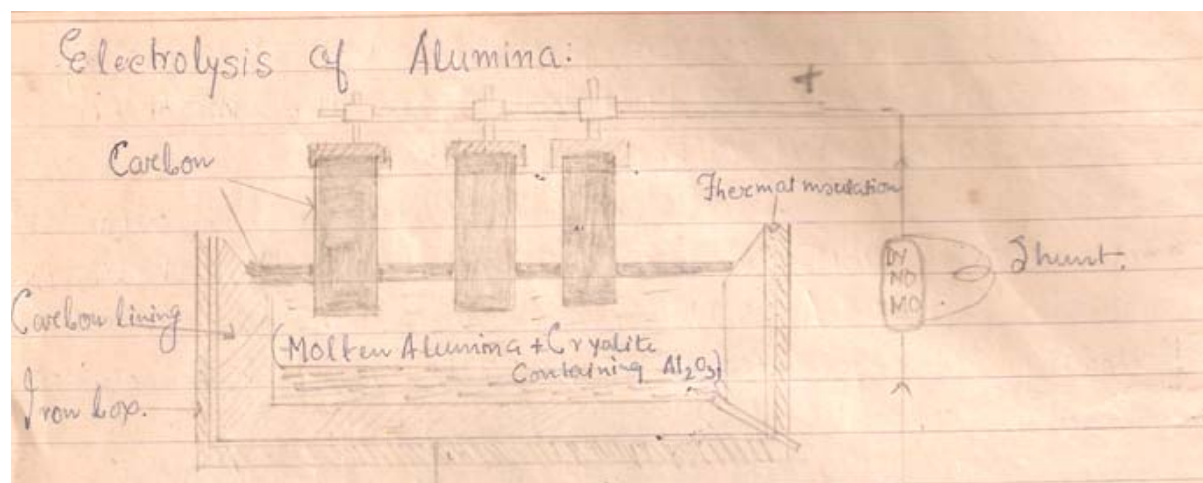


When the digestion is complete, the hot solution of Sodium Aluminate is filtered from the insoluble iron-oxide and other impurities.

This Sodium aluminate is allowed to cool, added with water, & agitated for several hours with a little $Al(OH)_3$ from outside. Due to the following reaction we get $Al(OH)_3$ as ppt, known as β Alumina. The ppt are filtered, washed with water and calcined to get nearly 99.5% pure Al_2O_3 .

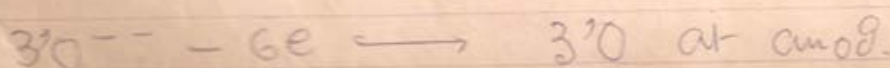
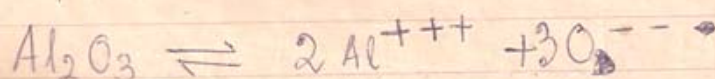


Aluminium



The concentrated alumina is mixed with cryolite and a little calcium fluoride (CaF_2) to lower the melting point of alumina from nearly 1200°C to 950°C . The mixture is converted into a molten mass by supplying sufficient heat with electricity (electro heating). To the molten mass low voltage electricity is passed for electrolysis. Due to electrolysis aluminium metal goes to cathode and is tapped out from the bottom of the rectangular vessel as shown in the figure. O_2 goes to Anode which at once reacts with carbon which is present above the molten mass to produce CO or CO_2 .

Fresh Alumina is added at intervals. When the supply of carbon in the bath becomes less the current passes through the shunt which is noted by indicator lamp. For electrolysis 5 to 6 volt is needed.



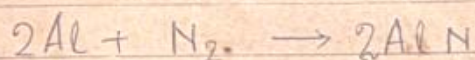
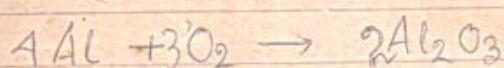
Aluminium



Refining (Purification): This aluminium may contain sand and iron as impurity. It is purified by electrolysis process called Hoope's process of electrolysis. The molten mass is directly electrolysed whereby pure molten Aluminium goes to cathode at the top which is tapped out and impurities go to anode.

Chemical Properties Of Aluminium.

1. With air \rightarrow When Aluminium is burnt in air it gives a bright flame forming both the oxide and the nitride.

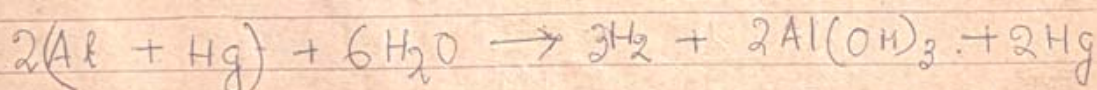


N.H

N.B When the burnt product is boiled with water we get Ammonia gas



2. With H_2O \rightarrow Pure Aluminium is not attacked by pure water due to the formation of protective oxide film on the surface but sea water reacts. Aluminium amalgam (Alloy of Zn + Hg) on boiling with water even at room temp^r gives H_2 .

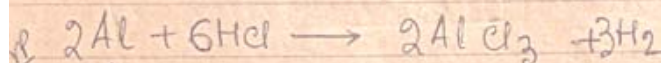


Aluminium

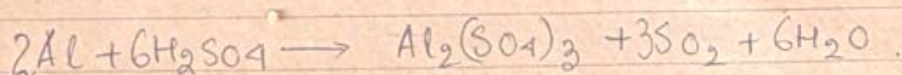


3. Acids

(a) With HCl \rightarrow It gives H_2 .

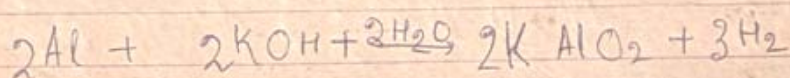


(b) ~~best~~ With dilute H_2SO_4 it has no action but with conc. Sulphuric acid it gives Sulphur dioxide on heating.



(c) With HNO_3 - NO reaction with dilute or conc. HNO_3 .

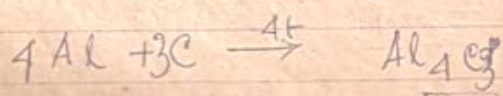
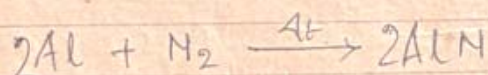
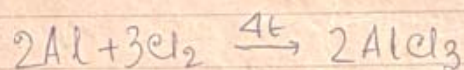
4. Alkali :- (KOH) :- When Aluminium is boiled with caustic potash it forms potassium Aluminate (K_2AlO_2)



M.B Same the case with NaOH. Caustic Soda.

Special

5. With Cl_2 \rightarrow When heated with Cl_2 / N_2 / S / C it gives the following products.



Aluminium



Uses of Aluminium.

1. For Electric wiring.
- *2. To prepare various alloy. (a) Magnesium - Al = 98%, Mg = 2%
is used for cheap balance, Car articles. (b) Aluminium - Bronze - Al = 10%, Cu = 90%. Used for coins, utensils and photo frame.
3. For fire works:-
4. For preparing food and cooking utensil.

Q. Goldschmidt aluminothermic process :-



Aluminium has strong affinity for oxygen.

In Gold-thermic process a mixture of Fe_2O_3 and Al powder (3:1) is taken in a crucible, ignited by Mg ribbon through ignition mixture as shown in the figure.

$$\text{Fe}_2\text{O}_3 + 2\text{Al} \longrightarrow \text{Al}_2\text{O}_3 + 2\text{Fe} + 199000 \text{ cal}$$

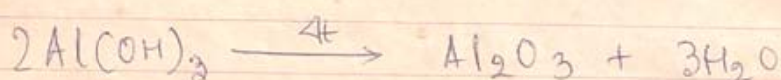
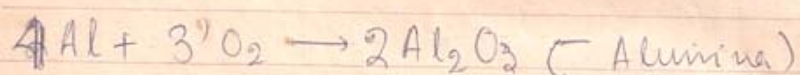
due to this reaction about 2500°C is obtained.
Whereby free iron is converted into a liquid.

Aluminium

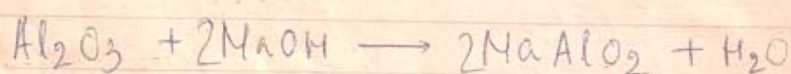


By knocking the cone iron is sent to the frame (mould) made of earth. Two iron bims are welded by this method.

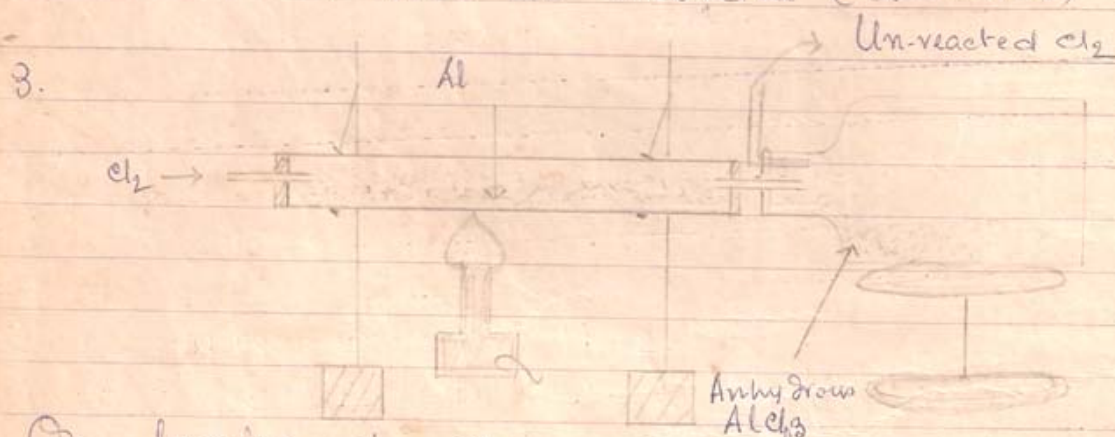
2. Alumina (Al_2O_3) - It is prepared by heating Aluminium in oxygen / $\text{Al}(\text{OH})_3$ in air.



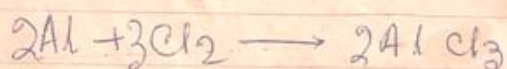
Prop It is white solid and amphoteric that is both acidic and alkalyne.



Uses It is highly used in organic preparations. It is used as medicine (antacids)



On passing dry Cl_2 gas over heated aluminium we get anhydrous AlCl_3



As shown in the diagram,

Aluminium



N:B When hydrated $AlCl_3 \cdot 6H_2O$ is heated instead of getting anhydrous $AlCl_3$ we get something else as follows



Uses It is used in Frydal Craft reaction,

Prop It is white crystalline deliquescent (which absorbs moisture),

(iv) Alums: The name Alum was given originally to double salts $K_2SO_4, Al_2(SO_4)_3 \cdot 24H_2O$ but the name alum is now given to all double salts of the type $M_2SO_4, R_2(SO_4)_3 \cdot 24H_2O$ where R = trivalent metals like $Al^{+++}, Cr^{+++}, Fe^{+++}$ etc and M is equal to Monovalent metals / non metal like Na, K, Rb, Cs and NH_4^+ .

1. e Common Alum / Potash alum, $K_2SO_4, Al_2(SO_4)_3 \cdot 24H_2O$,

2. $(NH_4)_2SO_4, Fe_2(SO_4)_3, 24H_2O$ Ferric ammonium Alum

3. Chrome Alum / Potassium Chromium alum

$K_2SO_4, Cr_2(SO_4)_3, 24H_2O$.

They are all isomorphous (same water of crystallization) and form Octahedral crystals.

Common Alum: When equimolecular weight of K_2SO_4 and $Al_2(SO_4)_3$ in saturated solution and in hot condition are mixed together and kept for some time we get big size of Common alum crystals. $K_2SO_4, Al_2(SO_4)_3 \cdot 24H_2O$

Aluminium



Properties :- It is octahedral crystal, astringent (i.e.) taste soluble in water. M.P = 92 °C. It loses all the water of crystallisation at 200°C leaving anhydrous salt known as "burnt alum."

Uses

1. To stop bleeding of small cut.
2. To purify water.
3. In leather industry, dye industry, paper industry and fire extinguisher. for medicine.

Dry test

1. Charcoal cavity test - In a charcoal block a cavity is made, ~~then~~ the salt is taken and heated by O.F then added two drops of Cobalt-nitrate and heated again ^{by O.F} we get blue / THENARD blue mass.

2. Wet Test

Salt solution is added with NH_4Cl and excess of NH_4OH (Thenard's reagent) we get white (fine) gelatinous ppt of $\text{Al}(\text{OH})_3$.