



*Dr. Bbosa Science*

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### Members

Elements	symbol
Boron	B
Aluminium	Al
Gallium	Ga
Indium	In
Thallium	Tl

### General comment

Boron is a nonmetal, aluminium is a metal whereas gallium, Indium and Thallium are weakly metallic.

Uses of boron

1. Boron is used in making heat resistant glasses
2. Boron is an essential nutrient.
3. Sodium tetra borate (borax),  $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$  is used to standardize hydrochloric acid solutions.  
 $\text{Na}_2\text{B}_4\text{O}_7 (\text{aq}) + 2\text{HCl} (\text{aq}) + 5\text{H}_2\text{O} (\text{l}) \rightarrow 2\text{NaCl} (\text{aq}) + 4\text{H}_3\text{BO}_3 (\text{s})$

### Aluminium

Aluminium is a light metal that is strong, malleable and ductile.

Its surface is protected by a thin layer of oxides that prevents it from being very reactive.

It is used for electric cables, sauce pans, tins, airplanes.

### Extraction of Aluminium

Ore: Bauxite ( $\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ )

Major impurities are

- ✓ Silica or  $\text{SiO}_2$
- ✓ Iron salts

### Principles in extraction

Extraction of aluminium involves removal of impurities (purification) and then reduction to metal by electrolysis.

Steps in extraction of Aluminium from bauxite ( $\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ )

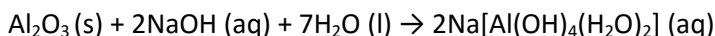
1. The ore is heated

- to remove water and,
- To convert iron salts to iron III oxide

## 2. Removal of Iron impurities

The powdered ore is heated with concentrated sodium hydroxide to dissolve aluminium oxide and silica such that the insoluble iron oxide is filtered off.

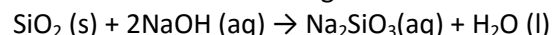
Aluminium oxide form aluminate



Or the ionic form

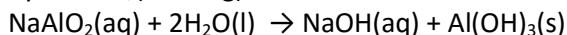


Silica also dissolves forming sodium silicate.

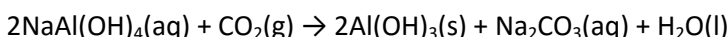


## 3. Separation of aluminium hydroxide from silicon impurities

To the filtrate a little aluminium hydroxide is added to precipitate Aluminium hydroxide,(seeding).

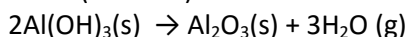


Alternatively carbon dioxide bubbled through the filtrate to precipitate aluminium hydroxide as follows



## 4. Recovering pure aluminium oxide

The precipitated aluminium hydroxide is filtered off, washed and ignited to give pure aluminium oxide (alumina).



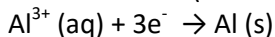
## 5. Extraction of aluminium from aluminium oxide by electrolysis

Aluminum is obtained from aluminium oxide by electrolysis.

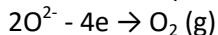
Cryolite,  $\text{Na}_3\text{AlF}_6$ , is added to aluminium oxide

- lower the melting point of alumina from  $2050^\circ\text{C}$  to  $900^\circ\text{C}$
- and improve conductivity of aluminium oxide

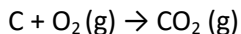
At the cathode (carbon) aluminium is liberated



At the anode (carbon) oxygen is liberated



The anode is eaten up by oxygen



### Trial 1

(a) During the extraction of aluminium, the ore is first purified.

- Write the name and formula of one ore from which aluminium is extracted. (1 marks)
- Name two main impurities in the ore. (1 marks)
- Name the reagent that is used in the purification of the ore. (1 marks)

(b) The purified ore is mixed with caryolite, melted and electrolyzed.

- State the purpose of adding caryolite. (1 mark)
- Name the electrodes used. (1 mark)
- Write an equation for the reaction that takes place at the cathode during the electrolysis. (2 marks)

Write an equation to show how anhydrous aluminium chloride can be obtained from

aluminium. (2 marks)

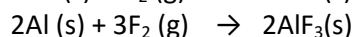
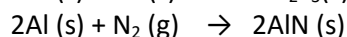
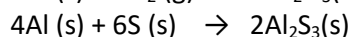
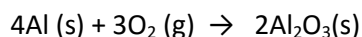
Trial 2

- (a) Write the formula of an ore of aluminium.
- (b) During the extraction of aluminium, the ore is first treated with sodium hydroxide, followed by aluminium hydroxide.
- (i) State the purpose of adding sodium hydroxide. (1.mark)
- (ii) Write an equation for the reaction between the ore and sodium hydroxide. (1½ marks)
- (iii) What is the purpose of adding aluminium hydroxide? (1 mark)
- (c) Briefly explain how aluminium can be obtained after the ore has been treated as in (b). (3.marks)
- (d) Carbon dioxide was used instead of aluminum hydroxide in (b). Write *an equation for the reaction that took place*.

### Reactions of aluminium

(a) with non-metals

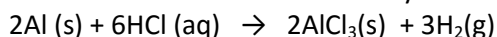
Aluminium combines directly with oxygen, sulphur, nitrogen and halogens at appropriate conditions.



The oxide and fluoride are ionic, and the rest are predominantly covalent.

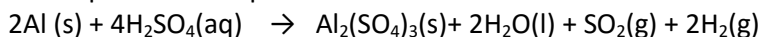
(b) Reaction with HCl

Aluminium reacts with moderately concentrated HCl to give a chloride and hydrogen gas.



(c) with sulphuric acid

Aluminum is not readily attacked by dilute sulphuric acid, but with the concentrated acid it gives the sulphate and sulphur dioxide and water.

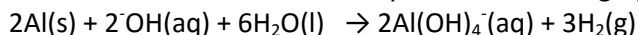


(d) Reaction with nitric acid

Aluminium does not react with nitric acid probably due to formation of an impenetrable oxide layer on the surface.

(e) **Reaction with sodium hydroxide**

Aluminium reacts with sodium hydroxide liberating hydrogen gas.



### Halides of aluminium

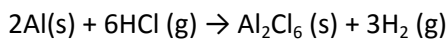
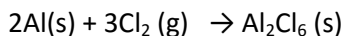
(a) **Aluminium fluoride (AlF<sub>3</sub>)**

It can be made by reacting metallic aluminium with fluorine. It is the only ionic aluminium halide and it is sparingly soluble in water.

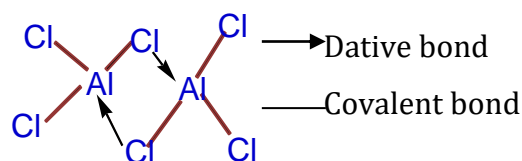
(b) **Aluminium chloride, Al<sub>2</sub>Cl<sub>6</sub>**

Preparation:

1. By passing hydrogen chloride or chlorine over heated metal under anhydrous conditions.

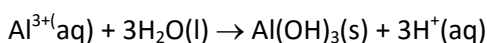


Structure of  $\text{Al}_2\text{Cl}_6$



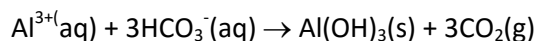
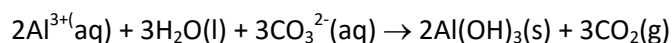
### Hydrolysis of aluminium salts

$\text{Al}^{3+}$  hydrolyze in solution to produce acidic solution that reacts with carbonate ions to liberate carbon dioxide



Consequently

- Aluminium salts solution blue litmus paper red
- Aluminium salts solution liberates carbon dioxide from carbonates and hydrogen carbonates with effervescence.



### Trial 3

(a) The relative molecular mass of aluminium chloride in a vapour phase is 267.

(i) Write the molecular formula of aluminium chloride in a vapour phase.

(ii) Write a structural formula to show the bonding in aluminium chloride vapour.

(iii) Note the types of bonds involved in the structure you have drawn in (ii) above.

Oxide of aluminium

### Preparation

By heating aluminium with oxygen or  
by heating aluminium hydroxide

