Chemistry

9th Class

Sindh Board Notes

Chapter # 16

Metals And Their Extraction

Theory Questions & Answers

Chapter # 16 Chemistry - IX

Theory & Question Answers

➔ METALS & THEIR EXTRACTION

16.1 INTRODUCTION

Q.1: Define metal and non metal?

Ans: METAL:
It is an element which ionizes by the loss of electrons to form positive ion easily.

NON METAL:
It is an element which ionizes by the gain of electrons to form negative ion easily.

Q.2: Write physical differences between metal and non metals?

Ans: DIFFERENCES BETWEEN METAL AND NON METALS:

Metals	Non-Metals
Metals are solids except mercury, with high melting points and boiling points.	About half of the non-metals are gases. They have low melting and boiling points.
Metals have characteristic lusture, known as metallic lusture and can be polished.	Non-metals do not have lusture like metals and can not be polished.
They on hitting with hamner give off notes i.e. they are sonorous.	They are not sonorous and break on hitting.
They are malleable and ductile that is they can be converted into sheets and wires.	They are neither malleable nor ductile.
They have relatively high densities.	They have relatively low densities.
Metals have great tensile strength and can withstand stress and strain.	They are usually brittle and break easily when subjected to stress or strain.
They are good conductors of heat electricity.	They are generally bad conductors of heat and electricity.
Some common metals are iron (Fe), Copper (Cu), aluminium (Al) and Chromium (Cr).	Some common examples of non- metals are sulphur(S) carbon (C) Oxygen (O_2) Nitrogen (N2) and Chlorine (Cl_2).

Q.2: Write chemical differences between metal and non metals?

Ans: DIFFERENCES BETWEEN METAL AND NON METALS:

Metals	Non-Metals
The oxides of metals are basic is character.	The oxides of non-metals are acidic in character.
When dissolved in water form alkaline solution.	When dissolved in water form acidic solution.
Metals ionize by the loss of electrons to form +ve ion.	They ionize by the gain of electrons to form -ve ion.
Metals have few electrons in their valence shells so have greater tendency to lose electrons during chemical reactions to form electrovalent or ionic compounds and form +ve ions.	Non-metals have more electrons in their valence shells, so they have the tendency to accept electrons in chemical reactions to form ionic or electrovalent compounds and form -ve ions.

Q.4: Write down the chemical properties of metals and non-metals?

Ans: CHEMICAL PROPERTIES OF METALS:

Reactions With Acid:

Metals which are more electropositive than hydrogen react with dilute acids to produce salts and hydrogen gas by the lass of electrons.

$$Zn_{(s)} + 2HCl \longrightarrow ZnCl_{2(aq)} + H_2$$

$$Mg_{(s)} + 2HNO_3 \longrightarrow Mg(NO_3)_{2(aq)} + H_2$$

$$2Al_{(s)} + 3H_2SO_{4(aq)} \longrightarrow Al_2(SO_4)_{3(aq)} + 3H_2$$

Reducing Agents:

Metals are generally reducing agents because they greater tendency to donate their electrons readily during chemical reactions.

$$\underset{\text{metal}}{2Na^o} + \underset{\text{non-metal}}{Cl_2^o} \longrightarrow 2Na^{+1}Cl^{-1}$$

$$\underset{\text{metal}}{Al^o} + \underset{\text{Non-metal}}{3S_2^o} \longrightarrow Al_2^{3+}S_3^{-2}$$

Nature Of Chlorides:

Metallic chloride are electrovalent i.e. ionic compounds. They are nonvolatile crystalline solids. They are good electrolytes. They have high melting points and are generally soluble in water.

$$Na^{+1}Cl^{-1}\left[Na + {}^{1}/_{2}\,Cl_2 \longrightarrow Na^{+1}Cl^{-1}\right]$$

Nature Of Hydrides:

Metals form very few compounds with hydrogen. However very electropositive metals like Na, K, Ca etc. combine with hydrogen to form ionic hydrides.

For example:

$$Na^{+}H^{-}_{(S)}\left[Na_{(S)} + \frac{1}{2}H_{2(S)} \longrightarrow Na^{+}H^{-}_{(S)}\right]$$

These metallic hydrides are salt like ionic solids. They are good electrolytes, soluble in water, but they react with water to liberate H_2 gas. This reaction is known as hydrolysis.

$$Ca^{+2}H_2 + 2H_2O_{(l)} \longrightarrow Ca(OH)_{2(aq)} + 2H_2$$

CHEMICAL PROPERTIES OF NON METALS:

Reactions With Acids:

Non-metals do not react with dilute acids, but some of non-metals get oxidized into their oxides or some oxy-acids, with hot concentrated acids.

$$C_{(S)} + 2HNO_{3(conc.)} \xrightarrow{Hot} CO_2 + 4NO_2 + 2H_2O_{(l)}$$

$$S_{(S)} + 6HNO_{3(conc.)} \xrightarrow{Hot} H_2SO_{4(aq)} + 6NO_2 + 2H_2O_{(l)}$$

$$S_{(S)} + 2H_2SO_{4(conc.)} \xrightarrow{Hot} 3SO_2 + 2H_2O_{(l)}$$

Oxidizing Agents:

Now-metals are generally oxidizing agents. They have the tendency to accept electrons easily during chemical reactions.

$$\underset{\text{Non-metal}}{Cl_2} + \underset{\text{Metal}}{2Na^{o}} \longrightarrow 2Na^{+1}Cl^{-1}$$

Nature Of Chlorides:

Non-metals form covalent chlorides by the sharing of electrons which are usually volatile liquids, easily hydrolyzed in water in most of the cases.

$$PCl_3\left[2P_{(S)} + 3Cl_2 \longrightarrow 2PCl_{3(S)}\right]$$

PCl_3 is hydrolyzed in water to form phosphorous acid and HCl.

$$PCl_{3(l)} + 3H_2O_{(l)} \longrightarrow H_3PO_{3(aq)} + 3HCl_{(aq)}$$

Nature Of Hydrides:

Non-metals combine with hydrogen to form stable covalent hydrides by the sharing of electrons, such as NH_3, H_2S, HCl etc. they are mostly gases and are generally non-electrolytes.

16.2 MINERALS AND ORES

Q.5: Define the following terms?

- Minerals
- Ores
- Metallurgy

Ans: MINERALS:

The combined form of metals with less definite chemical impurities is known as "minerals".

ORES:

Minerals when mixed with earthy materials are known as "Ores". An ore is mostly consists of a mixture of minerals with worthless rocky materials. These rocky materials present in ores are called "gangue particles.

For Example:

- Haematite (Fe_2O_3), Iron pyrite (FeS_2O) are the common ores of iron.
- Cuperite (Cu_2O), Copper pyrite ($CuFeS_2$) are the common ores of Copper.

METALLURGY:

The extraction of metal from its ore is called "metallurgy". It is the science and technology of extracting metals from their natural sources i.e. ores and making than for practical use.

16.3 METALLURGY

Q.6: Write down the preliminary operations or preparations involved in the metallurgy of metals form their ores?

Ans: PRELIMINARY PREPARATIONS:

An ore is usually cashed and grinded for the preliminary preparations.

Concentration Of The Ore:

Concentration of the ore is preformed only for sulphide ore. "Froth Floatation process" is a very sophisticated technique of the concentration of the ore. This process involves the mixing of finely divided ore with impurities with water and oil, especially pine oil or creosote oil. Air is blown in the mixture and the oil forming froth which floats on the surface and then the froth is skimmed off that contains the sulphide ore, while the gangue

particles present in the ore sink at the bottom. The froth is washed and dried, and is called "Concentrated Ore".

Roasting Of The Concentrated Ore:

The Concentrated ore is roasted in a furnace in air to remove the sulpher, carbon and other impurities from the ore. S and C are removed as SO_2 and CO_2 gases respectively, leaving behind the oxides of metals. Arsenic and antimony present are also bunt off in the process of roasting. The oxides are easier to deal with as compared to sulphides and carbonates.

$$4CuFeS_{2(S)} + 5O_2 \xrightarrow{Roasting} 2Cu_2S + 2FeO + 2FeS_{(S)} + 4SO_2$$

Smelting Of The Ore:

In this process, the roasted ore is mixed with sand i.e. silica (SiO_2) and Coke (c). The ore is now heated strongly until it melts. The remaining impurities present react with silica to form "Slag" of molten silicate. The slag is removed from the top of the molten mass and is discarded. The remaining molten mass left is called matte.

Reduction:

This process is applied to get free metals, in which a reducing agent or electron donor must be present to supply electrons three main methods, depending upon the nature of the particular metal.

- Chemical reduction
- Thermal reduction
- Electrolytic reduction

- **Chemical Reduction:**

  The less electropositive metals like Pb, Fe, Sn, Zn etc are usually obtained by reducing their oxides with coke or CO, which are cheaply available. For example, in case of Zn, its ore Zinc blend (ZnS) is first oxidized or converted into its oxide in the process of roasting. The oxide of Zinc is then reduced by heating it with coke.

$$2ZnS_{(S)} + 3O_2 \longrightarrow 2ZnO_{(S)} + 2SO_2$$

$$ZnO_{(S)} + C_{(S)} \longrightarrow Zn_{(S)} + CO$$

- **Thermal Reduction:**

  Some metals are reduced from their ores by direct heating e.g. mercury is obtained by simply heating its ore mercuric sulphide (HgS) in air.

$$HgS_{(S)} + O_2 \longrightarrow Hg_{(l)} + SO_2$$

- **Electrolytic Reduction:**

  More electropositive metals like Na, K, Ca, Mg etc. form compounds which are very stable and difficult to reduce chemically. The reduction of these metals occurs by

electrolytic reduction process by passing electric current though their molten salts specially chloride salts, for example Na metal is obtained by the electrolytic reduction of molten NaCl, when electric current is passed through the molten mixture of NaCl and $CaCl_2$ Electrolytic Reduction process is expensive and is applied when chemical method is not applicable.

$$2Na^+Cl^- \Longleftrightarrow 2Na^+_{(l)} + 2Cl^-_{(l)}$$

At Cathode:

$$2Na^+ + 2e^- \longrightarrow 2Na_{(S)}$$

16.4 METALLURGY OF IRON

Q.7: What are the chief ores of iron and the metallurgy of iron?

Ans: **CHIEF ORES OF IRON:**

Iron is the second most abundant metal after aluminum found in the earth crust. Iron has a great industrial importance. It is found in the combined state. Following are some important ores of iron.

- Limonite $Fe_2O_3\ 3H_2O$ (Hydrated)
- Haematite Fe_2O_3
- Iron Pyrite FeS_2
- Siclerite (or) Spathic $FeCO_3$
- Magnetite Fe_3O_4

Iron is also present in clay soil as iron silicate. It is an important part of haemoglobin.

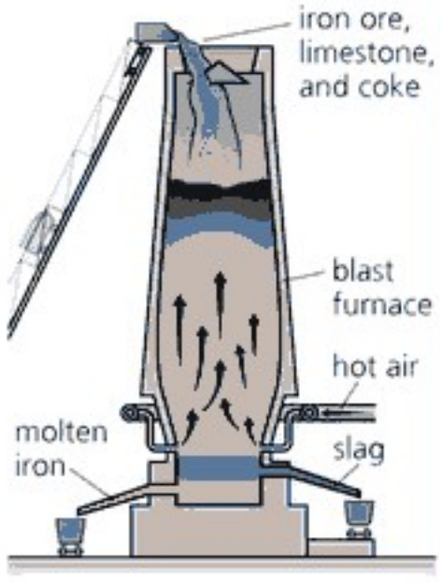
EXTRACTION OF IRON:

The most important ores from which iron metal is extracted are oxide ores i.e. Haematite (Fe_2O_3) or Limonite ($Fe_2O_3.3H_2O$).

BLAST FURNACE METHOD:

Reduction Of Oxides:

The reduction of oxide ores takes place in a blast furnace. This involves the crushing of the oxides ore to produce lumps, which are then pre-heated using hot gases from the blast furnace. This removes water and other volatile impurities present in the ore.



Roasting Of Iron Ore:

The toasted iron ores are charged with coke and lime stone ($CaCO_3$) which are fed from the top of the furnace, while a blast of hot air is introduced into it from the bottom through

small pipes known as tayeres.

Oxidation Of Coke:

The temperature inside the furnace varies from about 2000°C near the bottom to about 200°C at the top. The blast of hot air oxidizes the coke to CO_2 with the liberation of lot of heat.

$$C_{(S)} + O_2 \longrightarrow CO_2 \quad \Delta H = -394 \text{ KJ/mole}$$

The reaction is highly exothermic and raises the temperature of the furnace. CO_2 gas rises up the furnace and reacts with more coke, to produce CO gas.

$$CO_{2(S)} + C_{(S)} \xrightarrow{Heat} 2CO \quad \Delta H = +173 \text{ KJ/mole}$$

Formation Of Free Ion:

CO gas thus produced then reduced the iron oxide ore to free iron metal in the upper parts of the furnace. Here the temperature is between 477°C to 727°C.

$$Fe_2O_{3(S)} + 3CO \longrightarrow 2Fe_{(l)} + 3CO_2$$

Formation Of Calcium Silicate And Calcium Aluminates:

The limestone which has been introduced together with coke, decomposes at high temperature to yield calcium oxide (CaO) which then combines with silica (SiO_2) and aluminum oxide (Al_2O_3) present as impurities to form Calcium Silicate ($CaSiO_3$) and Calcium aluminates ($CaAl_2O_4$).

$$\underset{\text{Lime Stone}}{CaCO_{3(S)}} \longrightarrow CaO_{(S)} + CO_2$$

$$CaO + SiO_2 \longrightarrow CaSiO_{2(l)}$$

$$CaO + Al_2O_3 \longrightarrow CaAl_2O_{4(l)}$$

Slag Formation:

The mixture of $CaSiO_3$ and $CaAl_2O_4$ remains molten at the furnace temperature and is known as "Slag". It is a useful bye-product which is used for cement manufacturing making of road material light weight building materials.

Flue Gas:

The gas leaving the furnace is known as the "flue gas". It contains N, CO. CO_2 and fine solid particles including carbon particles. The emission of flue gas is a source of environmental pollutions.

Pig Iron:

The molten iron metal obtained from the blast furnace is run into sand mould where it cools down to solid blocks called "Pig iron". It is hard brittle and melts at 1227°C. It may

also be used directly to make steel. It is about 96% iron and 4% carbon, with small amounts of other impurities such as silica, sulphur, phosphorous and manganese.

Cast Iron:
Pig Iron is re-melted mixed with scrap steel and then cooled in mould to form "Cast Iron". it is used for making the gates, pipes, lamp posts, engine blocks stoves etc. It is brittle and difficult to weld because of the impurities.

Q.8: Write down the types of iron and differentiate between wrought iron and steel?

Ans: TYPES OF IRON:

Pig Iron:
Pig Iron is quite impure, which is directly obtained from the blast furnace the presence of impurities lowers the melting point of Pig Iron from 1530°C to 1200°C. It is hard and prattle so it has limited industrial uses. The impurities of the Pig Iron are given below in the form of table.

Cast Iron:
it is obtained from pig iron which is re-melted with some scrap steel and cooled in moulds of required shapes. It has slightly a lower percentage of impurities than pig iron, and almost has the same properties as pig iron. It is brittle so difficult to weld or forged. It is used for machinery objects which do not require greater tensile strength e.g. tools, lamp posts, rail rings, gates pipes, base of Bunsen burners, engine blocks etc.

Wrought Iron:
It is the purest commercial Iron, and contains only about 0.1% of carbon. It is obtained by heating the cast iron in a furnace with hematite (Fe_2O_3). During this process C and S are oxidized and are removed as CO_2 and SO_2 respectively.

$$2Fe_2O_{3(S)} + 3C \longrightarrow 4Fe_{(l)} + 3CO_2$$

$$2Fe_2O_{3_S} + 3S \longrightarrow 4Fe_{(l)} + 3SO_2$$

At the same time P and Si present are converted into phosphate and silicates of iron and are removed as a slag from the semi-molten mass of Iron. Wrought Iron is almost pure iron. Therefore it is soft but very tough and malleable. It can be shaped by hammering at about 500°C to 1000°C before its melting point. It can easily be welded and forged. It is used for making nails, chains, iron rods, sheets and horse shoes.

Steel:
It is an alloy of iron with carbon and other elements such as nickel, manganese, chromium, tungsten and vanadium. It is manufactured from Pig Iron. About 90% of Pig Iron is converted into steel. The main impurities of mild steel are given below in the table.

Impurity	Percent Impurity in Pig Iron	Percent Impurity in Steel
Carbon	3-5	0.15
Silicon	1-2	0.03
Sulphur	0.05-0.10	0.05
Phosphorous	0.05-1.5	0.05
Manganese	0.50-1.0	0.50

There are several methods of making steel. The most important methods are.

- The basic oxygen process.
- Open hearth process.
- The electric arc process.

However, they are all based on the same general principle of removing the impurities of C, Si, S, P and Mn from the molten Pig Iron and to obtain steel of desired compositions.

PROPERTIES OF IRON:

Properties of iron depend on its carbon content, the heat treatment it receives, tampering and the presence of other metals.

Carbon Content:

If Carbon content in steel is greater than in iron, then hardness and brittleness increase.

For Example

- Mild steel contains 0.1-0.25% of C and is soft, malleable and ductile.
- Medium steel contains 0.6-1.5% C are harder than mild steel.

Tempering:

Medium and hard steels can be heat-treated to produce steels with different degree of hardness and tensile strength for this, steel is heated to red hot and cool down suddenly. This steel is very hard and brittle to remove brittleness and to increase tensile strength; the steel is re-heated to certain carefully regulated temperatures and allowed to cool slowly. This process is known as tampering.

Composition Of Steel:

Alloy steels differ in their compositions. The properties of stainless steel depend upon their composition also.

For Example:

- The presence of Ni and Cr in stainless steel increases its resistance against rusting or corrosion. These steels are used in making cutleries, scissors, surgical instruments and machineries.
- The presence of cobalt gives highly magnetic steel used for making permanent magnets.

- Tungsten gives very hard steel for making cutting, drilling tools.

SOME COMMON STAINLESS STEEL:

- Stainless steel containing 13% Cr and 0.1 -0.4%C
- Stainless steel containing 17% Cr and 2 %Ni
- Stainless steel containing 118% Cr and 6 %Ni

Q.9: Differentiate between wrought iron and steel?

Ans: DIFFERENCE BETWEEN WROUGHT IRON AND STEEL:

Wrought Iron	Steel
Wrought Iron is the purest commercial iron.	Steel is an alloy of iron with C and other elements.
It is soft, but very tough and malleable.	It is hard, tough and strong.
Iron rusts when exposed to moist air.	It does not rust.

16.5 COPPER

Q.10: Write down Liz e occurrence of copper. How is copper extracted from its ore?

Ans: OCCURRENCE

Copper is very useful and important metal. It is relatively un-reactive. It is found generally in the combined states. The most important ores of copper are:

- Copper pyrite $CuFeS_2$
- Copper glance CuS
- Chalcocite Cu_2S
- Cuperite Cu_20
- Mala chite $CUCO_3.Cu(OH)_2$ (green)
- Azurite $[2CuCO_3.Cu(OH_2))$ (Blue)

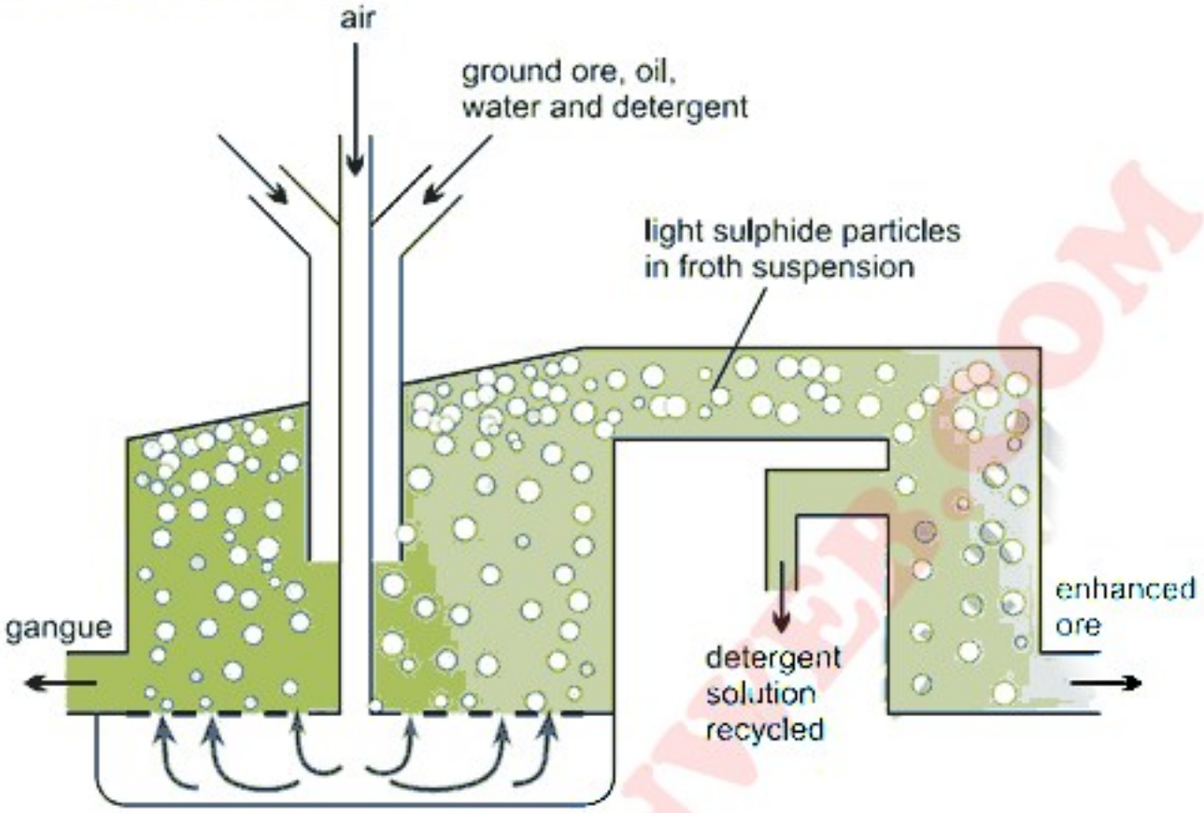
EXTRACTION OF COPPER:

Copper metal is usually extracted from its sulphide ores, such as copper pyrite ($CuFeS_2$) which contains about 6% copper. Extraction of copper from copper pyrite involves the following processes.

Concentration Of The Ore Froth Floatation:

The pyrite ore is first purified by concentration of the ore by the process of froth floatation. In this process the ore is crushed and is mixed with water and pine oil or creosote oil. Air is blown into the mixture, oil forms froth with sulphide ore, which floats to the surface, the gangue particles in ore, settle down. The sulphide ore particles tend to get coated with oil and are carried to the surface along with the froth. The froth along

with the mineral particles is skimmed off and is dried to get concentrated ore. The gangue particles are left behind.



Roasting:

This enriched concentrated ore is then roasted in an open-hearth furnace in air, port of sulphur and other furnace in arsenic and antimony are burnt off and are removed as their oxides.

$$4CuFeS_{2(S)} + 5O_{2(g)} \xrightarrow{roasted} 2Cu_2S_{(S)} + 2FeO_{(S)} + 2FeS_{(S)} + 4SO_2$$

Smelting:

The roasted ore is then changed into a blast furnace together with a little coke and silica (SiO_2). In the process of smelting sulphide ore is oxidized to oxide of iron, which combines with silica to form slag as iron silicate ($FeSiO_3$). The slag is removed which floats on the surface at regular intervals and is discarded.

$$2FeS_{(S)} + 3O_2 \longrightarrow 2FeO + 2SO_{2(g)}$$

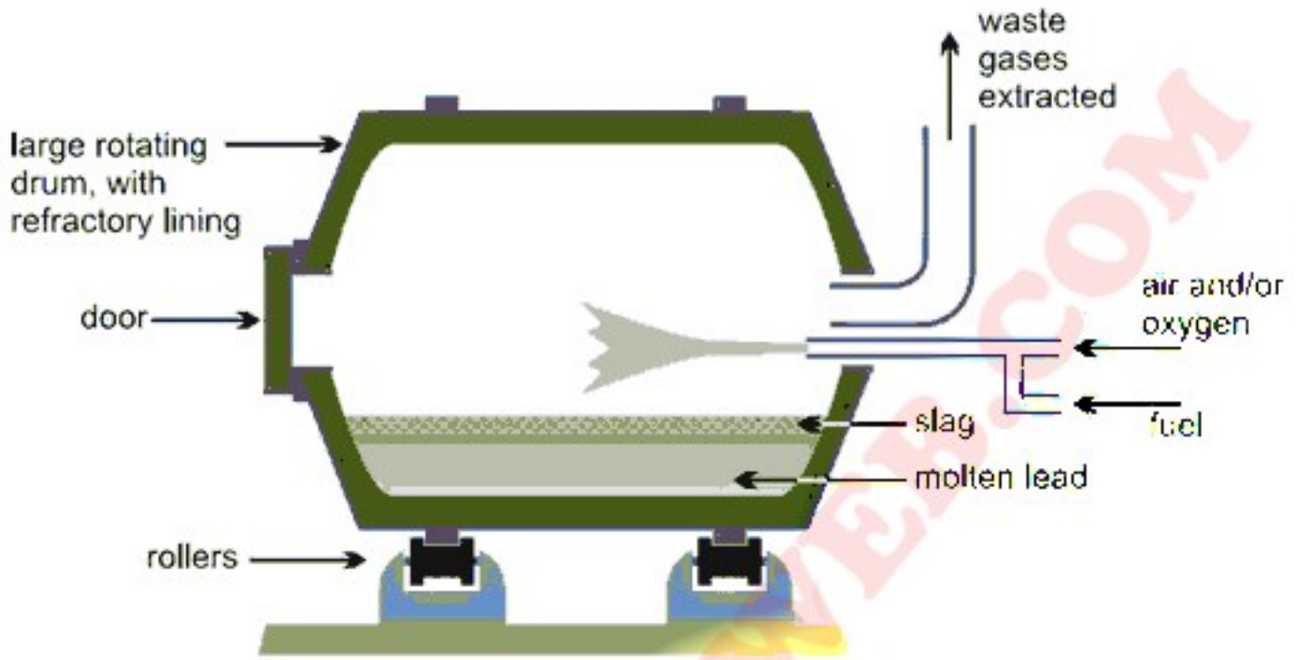
$$FeO + SiO_2 \longrightarrow FeSiO_{3(l)}$$

The molten mass below the slag comprises of cuperous suiphide (Cu_2S) mixed with some ferrous sulphide (FeS) known as "matte".

Reduction:

The molten copper matte Cu_2S with some unreacted FeS is carried out to a converter called "Bessemer Converted" where it is treated with some silica by blowing hot air.

The iron sulphide that escapes during smelting is oxidized to FeO, forming a slag with silica by blowing hot air. The blast of hot air converts Cu_2S partially to Cu_2O which then reacts with remaining Cu_2S to give metallic copper on reduction in the molten state.



Chemical Reactions

$$2FeS + 3O_2 \longrightarrow 2FeO + 2SO_{2(g)}$$

$$FeO_{(l)} + SiO_2 \longrightarrow FeSiO_{3(l)}$$

$$2CuS_{(l)} + 3O_2 \longrightarrow 2Cu_2O_{(l)} + 2SO_{2(g)}$$

$$2Cu_2O_{(l)} + Cu_2S_{(l)} \longrightarrow 6Cu_{(l)} + SO_{2(g)}$$

BLISTER COPPER:

The molten copper is poured into sand moulds. On cooling, thus solidified in sand moulds and is known as blister copper. It is produced during solidification on cooling due to the escape of dissolved SO_2 gas. It is about 98% pure copper. Blister copper contains impurities of iron, zinc, lead, silver, gold etc. Due to the presence of impurities, blister copper is not suitable for electrical work.

Refining Of Blister Copper:

Blister copper is refined by the electrolytic process. In this process blocks of impure copper are used as anode and very thin sheets of pure copper act as cathodes. These electrodes are suspended in copper sulphate ($CuSO_4$) solution, acidified with little amount of dilute sulphuric acid (H_2SO_4).

The electrolysis is carried out at 50°C by passing current of 1.3 volt, which helps to deposit pure copper metal at cathode by dissolving blister copper anodes forming Cu_2 ions. The impurities of less active metal like Zn, Ag, Au, etc are left over un-dissolved and fall at bottom of the cell as "anode mud."

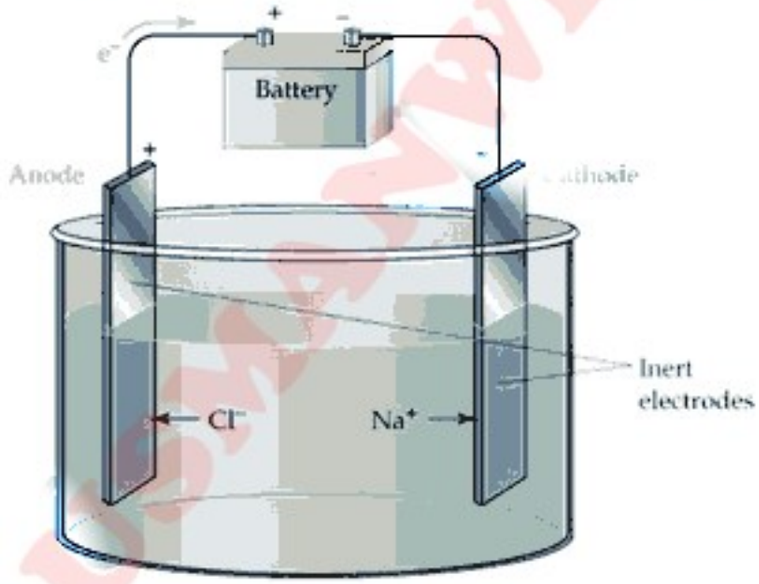
Reaction:
At anodes:

$$\underset{\text{Blister Copper}}{Cu_{(S)}} \longrightarrow Cu^{+2}_{(aq)} + 2e^-$$

At Cathode:

$$Cu^{+2}_{(aq)} + 2e^- \longrightarrow \underset{\text{Pure copper metal}}{Cu_{(S)}}$$

The electrically refined copper is 100% pure. Blister copper is refined because it has impurities of Fe, Zn, Pb, Ag, Au etc. Which reduce the conductivity of copper.



16.6 ALUMINIUM

Q.11: Give in detail the extraction of Aluminum and its occurrence?

Ans: OCCURRENCE:

Aluminum is the third most abundant metal found in the earth crust. It is present upto 7.6% in the earth's crust. It is less reactive than alkali and alkaline earth metals. It is found in combined states as silicates in rocks and clays the important.

Ores of Aluminum are:

Silicate Ores:

- Kaolin: $Al_2O_4.2SiO_2.2H_2O$
- Potash Felspar: $K_2O.Al_2O_3.6SiO_2$
- Potash mica: $K_2O.3Al_2O_3.6SiO_2.2H_2O$

Fluoride Ores:

- Cryolite: Na_3AlF_6

Sulphate Ores:

- Alunite: $K_2SO_4Al_2(SO_4)_3.4Al(OH)_3$

Oxide Ores:

- Bauxite: $Al_2O_3.nH_2O$ (or $Al_2O_3.2H_2O$)
- Diaspore: $Al_2O_3.H_2O$
- Corrundum: Al_2O_3

Q.12: Describe the extraction of aluminum?

Ans: EXTRACTION OF ALUMINUM:

Aluminum is extracted form its Bauxite ore. The industrial process used for the extraction of Aluminum is known as "Hall - Heroult process". This process is invented in 1886 by C.M Hall and L.T Heroult.

In this process Al metal is extracted in two stages.

- Crude bauxite is treated and purified to yield pure anhydrous alumina (Al_2O_3).
- This Al_2O_3 is then electrolyzed to get Al metal.

Purification Of Bauxite:

The Bauxite ore contains impurities of (Fe_2O_3) Ferric oxide and silica (SiO_2). These impurities are removed in the following steps.

- Bauxite ore is grinded and crushed finely.
- It is then heated with concentrated caustic soda (NaOH) solution under pressure to form sodium aluminates ($NaAlO_2$) or $NaAl(OH)_4$.
- Since the impurities of Fe_2O_3 and SiO_2 do not react with or dissolve in alkali, they can be removed easily by filteration and is known as "Sludge".

$$\underset{\text{Bauxite}}{Al_2O_3\,2H_2O_{(S)}} + 2NaOH_{(aq)} + 3H_2O \longrightarrow \underset{\text{hydrated sodium aluminates}}{2NaAl(OH)_4} + \text{Impurities}$$

OR

$$Al_2O_3\,2H_2O_{(S)} + 2NaOH_{(aq)} \longrightarrow \underset{\text{sodium aluminates}}{2NaAlO_{2(aq)}} + 3H_2O_{(l)} + \text{Impurities}$$

$NaAlO_2$ which is the filterate, is hydrosed with excess of water to precipitate aluminum hydroxide or aluminum oxide trihydrate ($Al_2O_3.3H_2O$), which is filtered, washed and dried.

$$2NaAl_2O + 4H_2O \longrightarrow Al_2O_3.3H_2O + 2NaOH$$

OR

$$2NaAl(OH)_4 \longrightarrow 2Al(OH)_3 + 2NaOH$$

$Al_2O_3.3H_2O$ or $Al(OH)_{3(S)}$ obtained is strongly heated upto 1500°C to yield pure alumina (Al_2O_3) on dehydration.

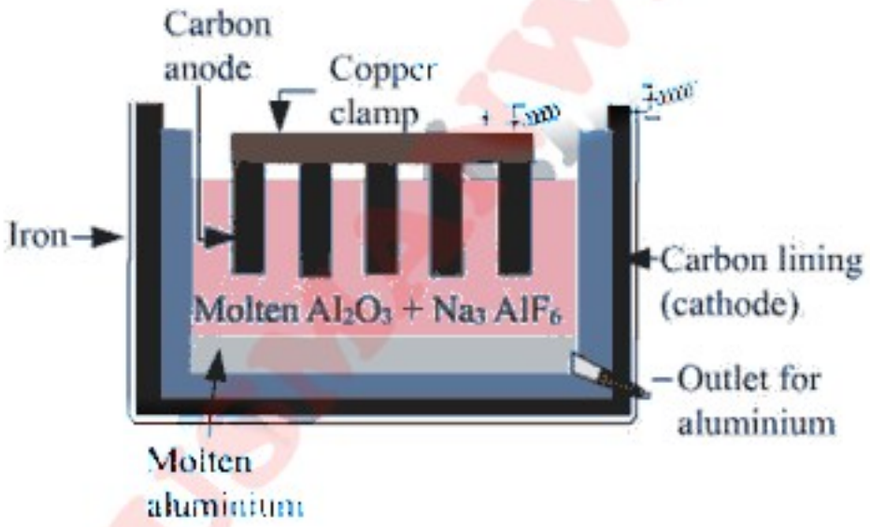
$$2Al(OH)_{3(S)} \longrightarrow \underset{\text{Pure alumina}}{Al_2O_{3(S)}} + 3H_2O$$

OR

$$Al_2O_3.3H_2O_{(S)} \longrightarrow \underset{\text{Pure alumina}}{Al_2O_{3(S)}} + 3H_2O$$

Electrolysis Of Pure Alumina:

The electrolysis of pure alumina is carried in a steel tank lined inside with graphite which acts as cathode, while anodes arc the graphite rods dipped in the molten mixture of pure alumina dissolved in molten cryolite (Na_3AlF_6) with some fluorspar (CaF_2). Cryolite lowers the melting point of pure alumina upto 950°C and maintains the temperature throughout the electrolysis, while fluorspar increases the fluidity of molten Al-metal Al^{+3} ions would be discharged at cathode.



Ionization Reaction:

$$2Al_2O_3 \underset{950°C}{\overset{cryolite}{\rightleftharpoons}} 4Al^{+3} + 6O^{-2}$$

An Cathode:

$$4Al^{+3} + 12e^- \xrightarrow{950°C} 4Al_{(l)}$$

At Anode:

$$6O^{-2} \longrightarrow 3O_2 + 12e^-$$

Molten aluminum metal is produced at cathode which flows down the cell and is tapped off form the outlet at the bottom of the cell periodically. O_2 gas is liberated at anode which interacts with the carbon of anode to form oxides of carbon. As a result the anodes are gradually burnt away and must be replaced from time to time.

Q.13: Write a note on Alloys?

Ans: ALLOYS:

Definition:

An alloy is a substance prepared by adding other metals or non-metals to a baser metal, so as to obtain certain desirable qualities.

Explanation:

An alloy can be considered as a uniform mixture of two or more metallic elements or non-metallic elements like carbon or silicon. The component elements do not undergo any chemical changes during the process of alloying. The percentage composition of the component elements may vary according to the quality desired.

Metals readily form alloys since metallic bond is non-specific. The presence of small quantities of a second element in the metal frequently increases its strength. The uses of a particular metal are governed by its chemical and physical properties. In most cases, a pure metal does not possess all the desired properties necessary. These short comings of the metal are usually eliminated by allowing the metal with one or more other substances usually metals or carbon e.g. pure iron is soft and is useless for many purposes. If however it is alloyed with Si, C, Mn, Cr, Ni or V etc, the resultant alloys are very useful.

SOME COMMON ALLOYS:

Bronze:

This is a very common alloy of baser metal copper. Bronze contains 90-95% copper and 5-10% Tin. It is strong enough to resist chemical attacks. It is an attractive alloy and used for making coins, medals, sculptures and also for general metallic work.

Brass:

Brass is an alloy of baser metal copper. It contains 60-80% copper and 20-24% Zn. It is more stronger and malleable than copper. It is of yellow colour and has low melting point is more attractive in appearance, and used for making moving parts of clocks and watches, nuts and bolts, rods, tubes, musical instruments, ornaments, household, furniture and for general metal work.

Nichrome:

It is an alloy that contains 60% nickel, 25% iron and 15% chromium. Nichrome is heat resistant and electrical resistant it is used in making of wires.

All Classes Chapter Wise Notes

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AJK Boards | Federal Boards

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