

## **PREFACE**

- This is an interactive self learning material exclusively meant for SSLC students of Kerala State Syllabus.
- This work is meant **only for** students appearing SSLC examinations , **march 2021**
- This is strictly in accordance with the Focus points suggested by SCERT
- **Scan the QR codes** given at each section to watch the video, related to the topic.
- You can also watch the videos using mobile,laptop etc by **clicking / touching the QR codes.** Make sure that the data connection is ON.
- Focus Points are marked as **♥♥♥**
- Constructive suggestions for further improvement are always welcome

# 4

## Production of Metals

Iron is used in making equipments ranging from pins to aeroplanes. Copper and aluminium have various uses in our daily life. Gold, silver and platinum used for making jewellery.

The chemically reactive metals are found in the combined state while the relatively unreactive metals (platinum, gold etc.) are found in the native state in the earth's crust.

### ♥♥♥ Minerals

The metallic compounds generally seen in the earth's crust are called minerals.

Example : Bauxite ( $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$ ), Cryolite ( $\text{Na}_3\text{AlF}_6$ ), Clay ( $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$ ) etc. are some of the minerals of aluminium.

1. What are the characteristics possessed, by minerals that are used for the extraction of metals?

- Abundance
- Easily and cheaply separable
- High metal content

### ♥♥♥ Ore

A mineral from which a **metal is economically, easily and quickly extracted**, is called the ore of the metal.

♥♥♥ Some metals and their ores are given below.

Metal	Ores	Chemical formula
Aluminium	Bauxite	$\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$
Iron	Haematite	$\text{Fe}_2\text{O}_3$
	Magnetite	$\text{Fe}_3\text{O}_4$
Copper	Copper pyrites	$\text{CuFeS}_2$
	Cuprite	$\text{Cu}_2\text{O}$
Zinc	Zinc blende	$\text{ZnS}$
	Calamine	$\text{ZnCO}_3$

2. ♥♥♥ All ores are minerals, but are all minerals ores. Justify.

The metallic compounds generally seen in the earth's crust are called minerals. But ore is a mineral from which the metal is economically, easily and quickly extracted.

## Metallurgy

It involves all the processes leading to the separation of a pure metal from its ore.

There are three important stages in metallurgy.

1. Concentration of ores
2. Extraction of metal from concentrated ore
3. Refining of metals

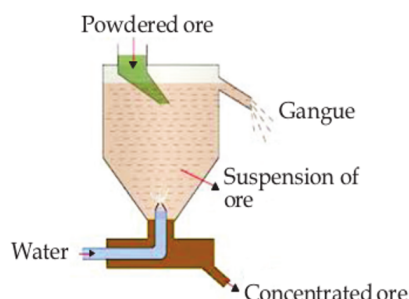
### I. ♥♥♥ Concentration of ores

The process of removing the impurities (*gangue*) from the ore obtained from the earth's crust is termed concentration of the ore. Depending on the nature of the ore and the impurities, there are different methods of concentration.

#### 1. ♥♥♥ Levigation or hydraulic washing

When the **impurities are lighter and the ore particles are heavier**, the lighter impurities are removed by washing in a current of water

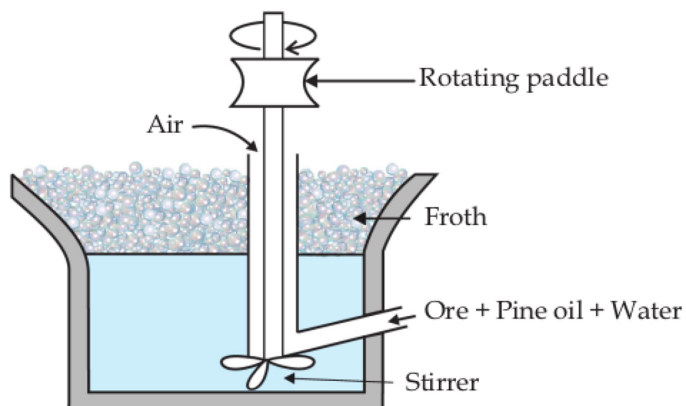
**e.g. concentration of oxide ores, concentration of the ores of gold.**



#### 2. ♥♥♥ Froth floatation

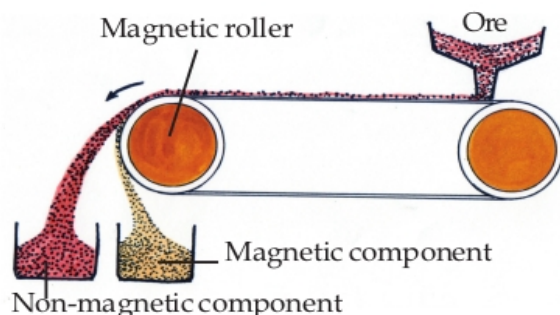
This process is used when the **impurities are heavier and the ore particles are lighter**.

**Sulphide ores** are usually concentrated by this method.



**3.♥♥♥ Magnetic separation**

If *either the ore or the impurity has magnetic nature*, concentration is done by this method. This method is used for the concentration of *magnetite*, ore of iron and also to separate *iron tungstate*, the magnetic impurity from *tin stone (SnO<sub>2</sub>)*, the *non-magnetic ore of tin*.



**4.♥♥♥ Leaching**

On adding the ore *to a suitable solution*, a chemical reaction takes place and *the ore dissolves*. *The insoluble impurities are filtered off*. The pure ore is separated from the filtrate by a chemical reaction.

*Bauxite, the ore of aluminium is concentrated by this method.*

3.♥♥♥ Complete the table given below



Properties of ores	Properties of the impurities present in the ore	The method of concentration
High density	Low density	.....
Magnetic in nature	Non - magnetic nature	.....
Lighter sulphide ores	High density	.....
Aluminium ores that get dissolved in a solution	Insoluble in the same solution	.....

**Answer:**

Properties of ores	Properties of the impurities present in the ore	The method of concentration
High density	Low density	<b>Levigation</b>
Magnetic in nature	Non - magnetic nature	<b>Magnetic separation</b>
Lighter sulphide ores	High density	<b>Froth floatation</b>
Aluminium ores that get dissolved in a solution	Insoluble in the same solution	<b>Leaching</b>

4. Write the suitable method of concentration of the following.

1. Tinstone    2. Bauxite    3. Zinc Blende

Answer:

Tinstone	Magnetic separation
Bauxite	Leaching
Zinc Blende (ZnS)	Froth floatation

(Why froth floatation for Zinc blende? . Answer: It is the sulphide ore )

## II. Extraction of metals from concentrated ore

It has usually two stages.

- Conversion of the concentrated ore into its oxide.
- Reduction of the oxide.

### (a) Conversion of concentrated ore into its oxide

i) **Calcination** : Calcination is the process of heating the concentrated ore in the absence of air at temperature below its melting point. Carbonates and hydroxides of metals decompose to form their oxides.

ii) **Roasting** : Roasting is the process of heating the concentrated ore in a current of air at a temperature below its melting point. When the concentrated ore is subjected to roasting, the moisture present in it is removed as vapour. Sulphide ore combines with oxygen to form oxide. e.g.  $Cu_2S$  ore is converted to  $Cu_2O$  by roasting.

### b) Reduction of the oxide

The process of extraction of metal from the oxide is reduction. Suitable reducing agents can be used for this purpose.

During the process of the production of metal, *electricity, carbon, carbon monoxide etc. are used as reducing agents* on the basis of the reactivity of the metal.

*Electricity* is used as the reducing agent to extract highly reactive metals like sodium, potassium and calcium from their ores.

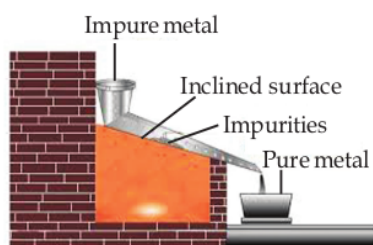
III.

### III. ♥♥♥ Refining of metals

The metal obtained by reduction may contain other metals, metal oxides and small quantities of non metals as impurities. Refining of metals is the process of removal of these impurities to get the pure metal. Depending on the nature of metals and the impurities present in them, different methods are used for the refining of metals. Some methods are given below.

#### a. ♥♥♥ Liquation

**Low melting metals like tin and lead** may contain other high melting metals or metal oxides as impurities. On heating such metals on the inclined surface of a furnace, the pure metal melts and flows down leaving the impurities behind. This process is termed liquation.



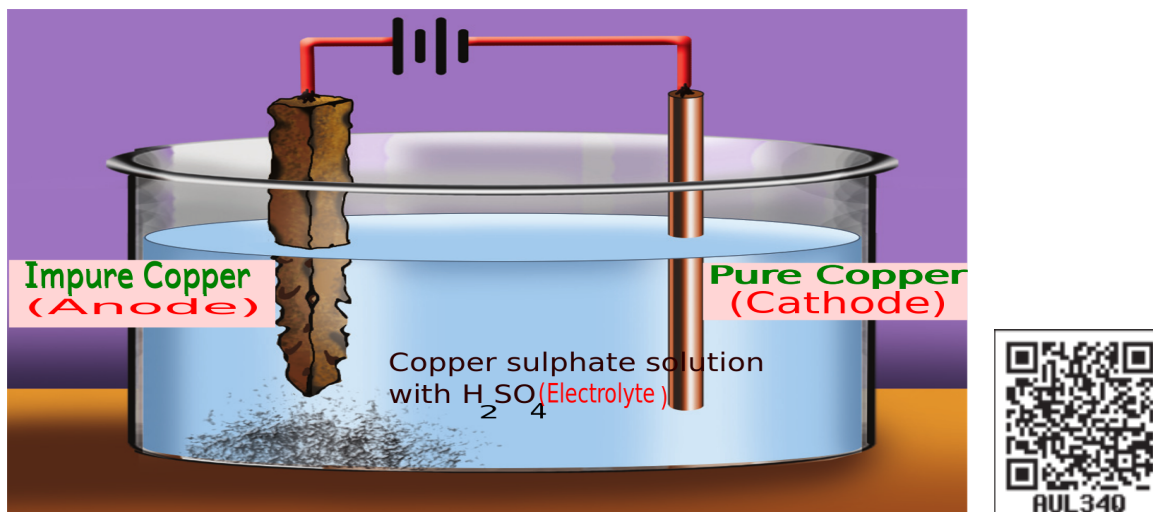
#### b. ♥♥♥ Distillation

This method is used for the refining of metals with **low boiling points such as zinc, cadmium and mercury**. When the impure metal is heated in a retort, the pure metal alone vapourises. The vapours are condensed to get the pure metal. This method is termed distillation.



**c. ♥♥♥♥ Electrolytic refining**

Electrolytic refining is the process of refining a metal by the electrolysis of a solution of the salt of the metal, using a small piece of pure metal as the negative electrode and the impure metal as the positive electrode. Copper can be refined by this method.



5. ♥♥♥♥ Observe the above picture and complete the following table.

Anode	
Cathode	
Electrolyte	
Equation of the chemical reaction taking place at anode	
Equation of the chemical reaction taking place at cathode	

Answer:

Anode	Impure Copper
Cathode	Pure Copper
Electrolyte	Copper sulphate solution
Equation of the chemical reaction taking place at anode	$\text{Cu} \longrightarrow \text{Cu}^{2+} + 2\bar{e}$
Equation of the chemical reaction taking place at cathode	$\text{Cu}^{2+} + 2\bar{e} \longrightarrow \text{Cu}$


♥♥♥ **Industrial production of iron**

Have a look at a student's science diary related to the production of iron.

♥♥♥ September 14

**Today's class**

**Industrial production of iron( Day 1)**



- Minerals of iron- Haematite, magnetite, iron pyrites etc.
- Iron pyrites - fool's gold. Reason : It has a yellow brazen colour which resembles gold.
- Ores of iron- Haematite( $\text{Fe}_2\text{O}_3$ ) , Magnetite( $\text{Fe}_3\text{O}_4$ )

**Iron is industrially prepared mainly from haematite.**

Impurities having low density are removed by **washing**.

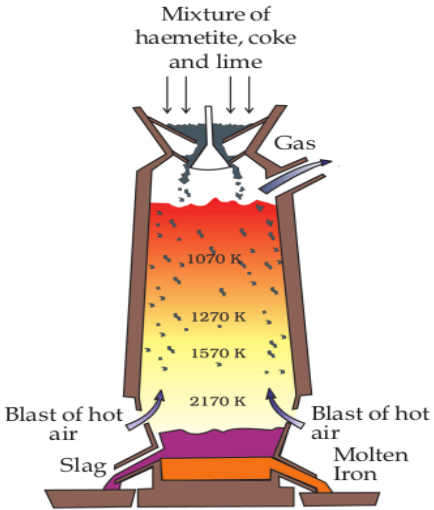
**Magnetic separation** is also employed .

**Roasting** . During **roasting** , impurities like sulphur, arsenic, phosphorous etc. are removed as their gaseous oxides. Water is also expelled along with this.

**[Washing. Magnetic separation. Roasting ]**

But the **gangue, silica ( silicon dioxide )** present in the ore is not removed.

Haematite is converted into iron by using the blast furnace.  
Blast of hot air is passed through the bottom of the furnace.  
That is why this furnace is called blast furnace.



September 15



**Today's class**

**Industrial production of iron (Day 2)**

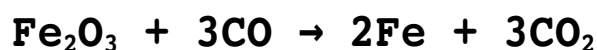


**Process**

Raw materials : Haematite( $\text{Fe}_2\text{O}_3$ ), limestone( $\text{CaCO}_3$ ) and coke(C).

Hematite, limestone and coke are fed into the furnace through a special arrangement at the top of the furnace.

**Reactions**



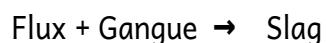
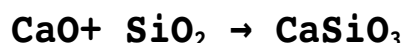
The reduction of haematite into iron is done mainly by this carbon monoxide.

(CO is the reducing agent)

Calcium carbonate decomposes to give calcium oxide and carbon dioxide at high temperature in the furnace.



This calcium oxide (flux) reacts with  $\text{SiO}_2$  (gangue) in the ore to form easily melting calcium silicate(slag).



If the gangue is acidic in nature, basic flux is to be used.

If the gangue is basic in nature, acidic flux is to be used.

The molten slag being less dense, floats over the molten iron.

**Pig iron**

The molten iron obtained from the blast furnace is called pig iron.

It contains 4% carbon and other impurities like manganese, silicon, phosphorus etc.

**FOCUS AREA 2020-21 Chemistry - Class 10-EM Unit 4**



Ore of iron	Haematite( $\text{Fe}_2\text{O}_3$ )
Raw materials fed into the blast furnace	Haematite( $\text{Fe}_2\text{O}_3$ ), limestone( $\text{CaCO}_3$ ) and coke(C)
The compound used for reducing haematite	Carbon monoxide (CO)
Gangue	$\text{SiO}_2$
Flux	CaO
Slag	$\text{CaSiO}_3$
Equation of formation of slag	$\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$ Flux + Gangue $\rightarrow$ Slag

## Production of Metals

### Stages of metallurgy - A Quick Review

Concentration of ores	Extraction of metal from concentrated ore	Refining of metals
It is the process of removing the impurities ( <i>gangue</i> ) from the ore.	It has two stages <b>(1) <u>Conversion of concentrated ore into its oxide</u></b>	It is the process of removal of impurities like other metals, metal oxides and small quantities of non metals remained after the reduction.
<b>1. Levigation ( Hydraulic washing)</b>	<b>i) Calcination</b>	<b>a. Liquefaction</b>
<b>Impurities are lighter</b> and the ore particles are heavier.	Heating the concentrated ore in <b>the absence of air</b> at a temperature below its melting point.	On heating low melting metals on an inclined surface of a furnace, the pure metal melts and flows down leaving the impurities behind.
<i>Oxide ores , ores of gold</i>	<i>Carbonates and hydroxides of metals</i>	<i>Low melting metals like tin and lead</i>
<b>2. Froth floatation</b>	<b>ii) Roasting</b>	<b>b. Distillation</b>
<b>Impurities are heavier</b> and the ore particles are lighter.	Heating the concentrated ore <b>in a current of air</b> at a temperature below its melting point.	The impure metal is heated in a retort, the pure metal alone vapourises The vapours are condensed to get the pure metal.
<b>Sulphide ores</b>	The moisture present in it is removed as vapour. Sulphide ore combines with oxygen to form oxide. <b>Cu<sub>2</sub>S ore is converted to Cu<sub>2</sub>O by roasting.</b>	For metals with low boiling points such as <b>zinc, cadmium and mercury.</b>

**FOCUS AREA 2020-21 Chemistry - Class 10-EM Unit 4**

3. Magnetic separation	(2) <u>Reduction of the oxide</u>	c. Electrolytic refining
<i>Either the ore or the impurity has magnetic nature</i>	<i>Electricity, carbon, carbon monoxide etc. are used as reducing agents on the basis of the reactivity of the metal.</i>	<i>Using a solution of the salt of the metal. A small piece of pure metal as the negative electrode and the impure metal as the positive electrode.</i>
1. <b>Magnetite</b> , ore of iron. 2. <b>Iron tungstate, the magnetic impurity</b> from tin stone( $\text{SnO}_2$ ), the non-magnetic ore of tin	Electricity is used as the reducing agent to extract highly reactive metals like sodium, potassium and calcium from their ores.	Refining of copper
<b>4. Leaching</b> Ore + Suitable solvent. Chemical reaction occurs and ore dissolves. The insoluble impurities are filtered off. The pure ore is separated from the filtrate by chemical reaction.		
<b>Bauxite</b> , the ore of aluminium		