UNIT – 1 – METALLURGY

II. Answer the following questions: **[QY-23, APR-24]**

1. What is the difference between minerals and ores? [QY19,SEP20,FMT,HY,FRT,MAY22]

Minerals	Ores
A naturally occurring substance obtained by mining which contains the metal in free state or in the form of compounds.	Ore contains a high percentage of metal, from which it can be extracted conveniently and economically.
They have definite crystalline structure	They do not have definite crystalline structure
All minerals are not ores	All ores are Minerals
It contains a low percentage of metal	It contains a high percentage of metals
Ex: Mineral of Al is bauxite and china clay	**Ex:** Ore of Al is bauxite

2. What are the various steps involved in the extraction of pure metals from their ores?

The extraction of pure metals from the concentrated ores is carried out in two steps:

- Conversion of the ore into oxides of the metal of interest.
- Reduction of the metal oxides to elemental metals.

3. What is the role of Limestone in the extraction of Iron from its oxide Fe_2O_3? [SEP-20, FRT-22, FUT-23]

In the extraction of iron, a basic flux limestone is used. Limestone decomposes to form CaO which reacts with silica gangue present in the iron ore is acidic in nature to form calcium silicate (slag).

$$\underset{\text{Flux}}{CaO\ (s)} + \underset{\text{Gangue}}{SiO_2\ (s)} \longrightarrow \underset{\text{Slag}}{CaSiO_3\ (s)}$$

4. Which type of ores can be concentrated by froth floatation method? Give two examples for such ores. [SEP-20, FRT-22, MAR-23]

- Sulphide ores can be concentrated by the froth floatation method.
- (Eg) Galena (PbS), Zinc blende (ZnS).

5. Describe a method for refining nickel. (or) How is Ni purified by Mond process? (or) Explain the purification of Nickel. [PTA-3, FMT, HY, FRT, MAY-22, FUT-23, HY-23]

- The impure nickel is heated in a stream of carbon monoxide at around 350K.
- The nickel reacts with the CO to form a highly volatile nickel tetracarbonyl.
- The solid impurities are left behind. $Ni\ (s) + 4\ CO\ (g) \longrightarrow [Ni(CO)_4]\ (g)$
- On heating the nickel tetracarbonyl around 460K, the complex decomposes to give pure metal. $[Ni(CO)_4]\ (g) \longrightarrow Ni\ (s) + 4\ CO\ (g)$

6. Explain zone refining process with an example.[PTA-6, MAR20, FMT-22, FRT, MAR, JUN-23, FUT-23]

- This method is based on the principle of fractional crystallization. The impure metal is melted and allowed to solidify, the impurities will prefer to remain in the molten region, ie; impurities are more soluble in the melt than in the solid-state metal.
- In this process, the impure metal is taken in the form of a rod. One end of the rod is heated using a mobile induction heater, melting the metal on that portion of the rod.

- When the heater is slowly moved to the other end pure metal crystallizes while impurities will move on to the adjacent molten zone formed due to the movement of the heater.
- As the heater moves further away, the molten zone containing impurities also moves along with it.
- This process is repeated several times by moving the heater in the same direction again and again to achieve the desired purity level.
- This process is carried out in an inert gas atmosphere to prevent the oxidation of metals.
- Germanium, Silicon, and gallium which are used as semiconductors are refined by this process.

7. Using the Ellingham diagram, (A) Predict the conditions under which (i) Aluminium might be expected to reduce magnesia. (ii) Magnesium could reduce alumina.
(B) It is possible to reduce Fe_2O_3 by coke at a temperature around 1200 K.

(A) (i) Ellingham diagram for the formation of Al_2O_3 and MgO intersects around 1600K.
- Above this temperature aluminium lines lies below the magnesium line.
- Hence we can use aluminium to reduce magnesia above 1600K.

(ii) In Ellingham diagram below 1600K magnesium line lies below aluminium line.
- Hence, below 1600K magnesium can reduce alumina.

(B) In Ellingham diagram above 1000K carbon line below the iron line.
- Hence, it is possible to reduce Fe_2O_3 by coke at a temperature around 1200K.

8. Give the uses of zinc. [PTA-4]
- Metallic zinc is used in galvanising metals such as iron and steel structures to protect them from rusting and corrosion.
- Zinc is also used to produce die-castings in the automobile, electrical and hardware industries.
- Zinc oxide is used in the manufacture of many products such as paints, rubber, cosmetics, pharmaceuticals, plastics, inks, batteries, textiles arid electrical equipment.
- Zinc sulphide is used in making luminous paints, fluorescent lights and x-ray screens.
- Brass an alloy of zinc is used in water valves and communication equipment as it is highly resistant to corrosion.

9. Explain the electrometallurgy of aluminium. [GMQP-19, FMT-22, SRT-24]

Cathode : Iron tank lined with carbon **Anode** : Carbon blocks

Electrolytes: 20% solution of alumina, obtained from the bauxite ore is mixed with molten cryolite and is taken in the electrolysis chamber. About 10%, calcium chloride is also added to the solution. Here calcium chloride helps to lower the melting point of the mixture.

Temperature : Above 1270 K.

The chemical reactions involved in this process are as follows:

Ionisation of alumina: $Al_2O_3 \rightarrow 2Al^{3+} + 3O^{2-}$

Reaction at cathode: $2Al^{3+}$ (melt) $+ 3e^- \rightarrow Al_{(l)}$

Reaction at anode: $2O^{2-}$ (melt) $\rightarrow O_2 + 3e^-$

- Since carbon acts as anode the following reaction also takes place on it.

$$C_{(s)} + O^{2-}\ (melt) \rightarrow CO + 2e^{-}$$

$$C_{(s)} + 2O^{2-}\ (melt) \rightarrow CO_2 + 4e^{-}$$

- Due to the above two reactions, anodes are slowly consumed during the electrolysis.
- The pure aluminium is formed at the cathode and settles at the bottom.
- The net electrolysis reaction can be written as follows:

$$4Al^{3+}\ (melt) + 6O^{2-}\ (melt) + 3C_{(s)} \rightarrow 4A_{(l)} + 3CO_{2(g)}$$

10. Explain the following terms with suitable examples. [PTA-2, SEP-20, FRT-22]

(i) Gangue (ii) Slag

(i) Gange: The non-metallic impurities, rocky materials and siliceous matter, associated with the ore is called gangue. **Example:** SiO_2 is the gangue present in the iron ore.

(ii) Slag: Slag is the fusible product formed when flux reacts with gangue during the extraction of metal. **Example:**

$$\underset{Flux}{CaO_{(s)}} + \underset{Gangue}{SiO_2} \longrightarrow \underset{Slag}{CaSiO_3}$$

11. Give the basic requirement for vapour phase refining.

The two requirements for vapour phase refining are:

- The metal should form a volatile compound with a suitable reagent.
- The volatile compound is decomposed to give the pure metal.

12. Describe the role of the following in the process mentioned. (i) Silica in the extraction of copper. (or) What is the role of silica in extraction of copper? [FMT-22, APR-24] (ii) Cryolite is the extraction of aluminium. [QY-19] (iii) Iodine in the refining of Zirconium. [QY-19] (iv) Sodium cyanide in froth floatation. [FMT-22]

(i) The role of silica in the extraction of copper is to remove the iron oxide obtained during the process of roasting as slag. If the sulphide ore of copper contains iron, the silica (SiO_2) is added as flux before roasting. Then, FeO combines with silica to form iron silicate, $FeSiO_3$ (Slag).

(ii) Cryolite reduces the melting point of Al_2O_3 and increases its electrical conductivity. Aluminium is produced by the electrolytic reduction of fused alumina in the electrolytic cell. Alumina is not an electrolyte. So it is made as an electrolyte by dissolving it in the fused cryolite. The function of cryolite is to lower the fusion temperature.

(iii) Zirconium crude metal is heated with iodine in an evacuated vapour to separate from impurities and this decomposes at 1800 K to give a pure zirconium metal and iodine. Initially, iodine is heated with zirconium to form a volatile compound.

(iv) Sulphide ores are concentrated by the froth floatation process. Depressants are used to prevent a certain types of particles from forming the froth. NaCN act as a depressant to separate ZnS from PbS.

13. Explain the principle of electrolytic refining with an example. (or) How is silver purified by electrolytic refining process? [HY-19, FRT,JULY-22, QY-23]

- Electrolytic refining is carried out in an electrolytic cell

Cathode : Thin strips of pure metal **Anode** : Impure metal

Electrolyte : Acidified aqueous solution of salt of the metal.

- The metal of interest dissolves from the anode, pass into the solution while the same amount of metal ions from the solution will be deposited at the cathode.
- During electrolysis, the less electropositive impurities in the anode, settle down at the bottom and are removed as anode mud.
- Electrolytic refining of silver as an example.

Cathode : Pure silver **Anode** : Impure silver rods

Electrolyte : Acidified aqueous solution of silver nitrate.

- When a current is passed through the electrodes the following reactions will take place

Reaction at anode $Ag(s) \longrightarrow Ag^{+}(aq) + 1e^{-}$

Reaction at cathode $Ag^{+}(aq) + 1e^{-} \longrightarrow Ag(s)$

- During electrolysis, at the anode the silver atoms lose electrons and enter the solution.
- The positively charged silver cations migrate towards the cathode and get discharged by gaining electrons and deposited on the cathode.

14. The selection of reducing agent depends on the thermodynamic factor. Explain with an example.

- From the Ellingham diagram, it is clear that metals for which the standard free energy of formation (ΔfG0) of their oxides is more negative can reduce the metal oxides for which the standard free energy of formation (ΔfG0) of oxides is less negative.
- The thermodynamic factor has a major role in selecting the reducing agent for a particular reaction. Only that reagent will be preferred which will lead to a decrease in the free energy (AG°) at a certain specific temperature. E.g – Carbon reduce ZnO to Zn but not CO.

$ZnO + C \rightarrow Zn + CO$ ……(1) $ZnO + CO \rightarrow Zn + CO_2$ ……(2)

- In the first case, there is increase in the magnitude of ΔS° while in the second case, it almost remains the same. In other words, ΔG° will have more negative value in the first case, when C is the reducing agent then in the second case when CO acts as the reducing agent.
- Therefore, C is a better reducing agent.

15. Give the limitations of Ellingham diagram. [HY-22, FRT-23, JUN-23, HY-23]

- Ellingham diagram is constructed based only on thermodynamic considerations.
- It gives information about the thermodynamic feasibility of a reaction.
- It does not tell anything about the rate of the reaction. Moreover, it does not give any idea about the possibility of other reactions that might be taking place.
- The interpretation of ΔG is based on the assumption that the reactants are in equilibrium with the product which is not always true.

16. Write a short note on electrochemical principles of metallurgy. [QY-23]

- Electrochemical principles also find applications in metallurgical process.
- The reduction of oxides of active metals such as sodium, potassium etc., by carbon is thermodynamically not feasible.
- Such metals are extracted from their ores by using electrochemical methods.
- In this technique, the metal salts are taken in a fused form or in solution form.

- The metal ion present can be reduced by treating it with some suitable reducing agent or by electrolysis.
- Gibbs free energy change for the electrolysis process is given by the following expression

$$\Delta G^\circ = -nFE^\circ$$

- Where n is number of electrons involved in the reduction process, F is the Faraday and E° is the electrode potential of the redox couple.
- If E° is positive then the ΔG is negative and the reduction is spontaneous and hence a redox reaction is planned in such a way that the e.m.f of the net redox reaction is positive.
- When a more reactive metal is added to the solution containing the relatively less reactive metal ions, the more reactive metal will go into the solution.
- For example, $Cu_{(s)} + 2Ag^+_{(aq)} \rightarrow Cu^{2+}_{(aq)} + 2Ag_{(s)}$

$$Cu^{2+}_{(aq)} + Zn_{(s)} \rightarrow Cu_{(s)} + Zn^{2+}_{(aq)}$$

EVALUATE YOURSELF

1. Write the equation for the extraction of silver by leaching with sodium cyanide and show that the leaching process is a redox reaction.

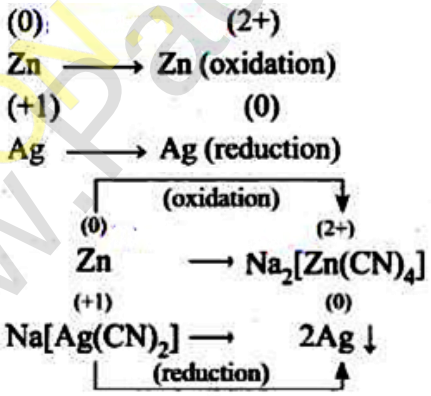
The crushed ore of argentite (Ag_2S) is leached with sodium cyanide solution. This reaction forms sodium Argento cyanide $Na[Ag(CN)_2]$

Step 1: $Ag_2S + 4NaCN \rightleftharpoons 2Na[Ag(CN)_2] + Na_2S$

The solution of sodium Argento cyanide combines with zinc dust and forms sodium tetra cyano zincate and precipitated silver.

Step 2: $Zn + 2Na[Ag(CN)_2] \rightarrow Na_2[Ag(CN)_4] + 2Ag\downarrow$

In the step 2, redox reaction take place.



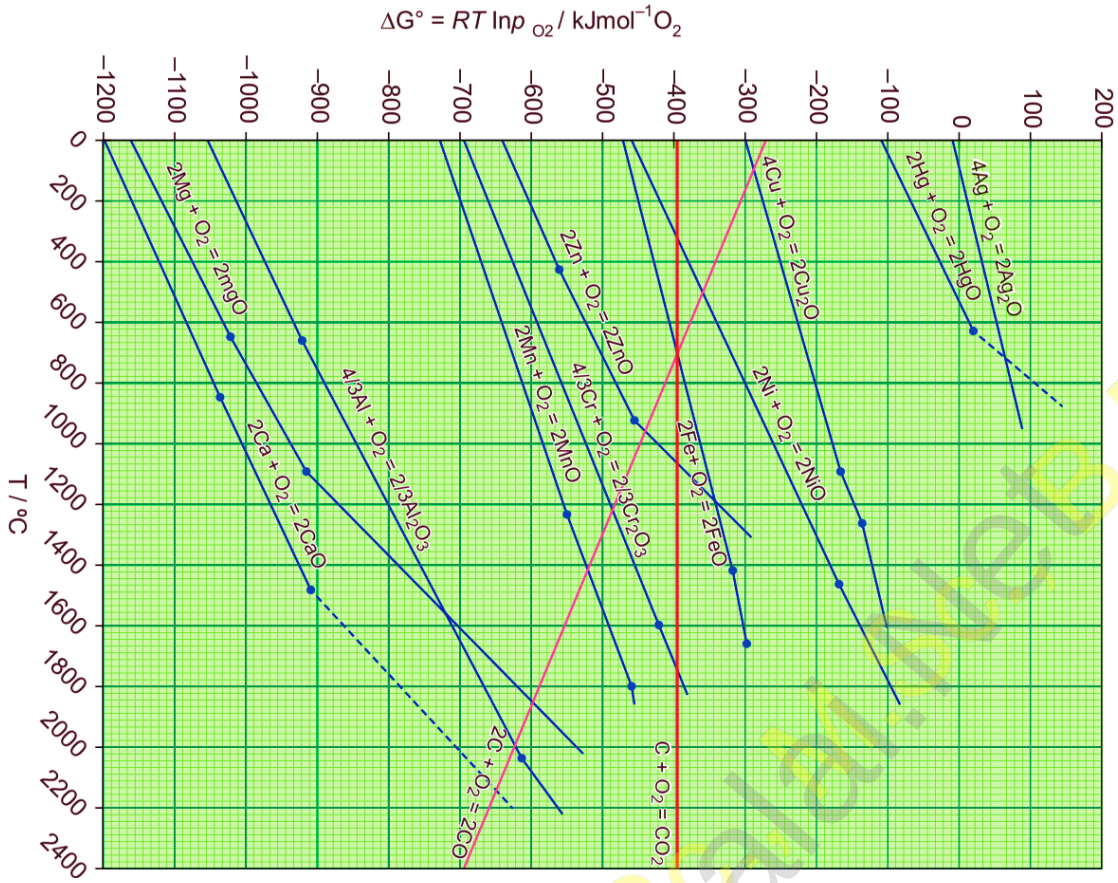
2. Magnesite (Magnesium carbonate) is calcined to obtain magnesia, which is used to make refractory bricks. Write the decomposition reaction.

Magnesite is a carbonate of magnesium. Magnesite when heated at 800°C to 1000°C at the CO_2 content in it is driven off. The residue so obtained is known as calcined magnesite.

$$MgCO_3 \rightarrow MgO + CO_2\uparrow$$

3. Using Ellingham diagram indicate the lowest temperature at which ZnO can be reduced to zinc metal by carbon. Write the overall reduction reaction at this temperature.

Ellingham diagram for the formation of ZnO and CO intersects around 1200K. Below this temperature the carbon line lies above zinc line. Hence ZnO is more stable than CO so the reduction is thermodynamically not feasible at this temperature range.



However above 1200K carbon line lies below the zinc line, hence carbon can be used as a reducing agent above 1200K.

$2Zn + O_2 \rightarrow 2ZnO$ (1) $2C + O_2 \rightarrow 2CO$ (2)

Reversing (1) and adding with equation (2)

$2ZnO \rightarrow 2Zn + O_2$ $2CO \rightarrow 2C + O_2$ $2ZnO + 2C \rightarrow 2Zn + 2CO$

4. Metallic sodium is extracted by the electrolysis of brine (aq. NaCl). After electrolysis, the electrolytic solution becomes basic in nature. Write the possible electrode reactions.

Brine is a solution of sodium chloride (molten state):

The process of electrolysis involves using an electric current to bring about a chemical change and make new chemicals. In the electrolysis of brine, sodium ions migrate to the cathode, where electrons enter the melt and are reduced to sodium metal.

$$Na^+ + e^- \rightarrow Na \text{ (at cathode)}$$

Chloride ions migrate the other way toward the anode. They give up their electrons to the anode and are oxidised to chlorine gas.

$$Cl^- \rightarrow \frac{1}{2}Cl_2 + e^- \text{ (at anode)}$$

Overall reaction: $2NaCl \rightarrow 2Na_{(s)} + Cl_{2(g)}$

For aqueous solution of NaCl:

$H_2O + 2e^- \rightarrow \frac{1}{2}H_2\uparrow + OH^-$ (at cathode) $Cl^- \rightarrow \frac{1}{2}Cl_2 + e^-$ (at anode)

Overall reaction: $NaCl_{(aq)} + H_2O_{(1)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)} + \frac{1}{2}H_{2(g)} + \frac{1}{2}Cl_{2(g)}$

After electrolysis the electrolytic solution becomes basic in nature. [Due to formation of hydroxide (OH^-) ion].

UNIT – I - METALLURGY | Mr. S.JOHNSON., M.Sc., M.Sc., B.Ed.,

GOVERNMENT EXAM QUESTION PAPER

1. Oxides like Ag_2O and HgO undergo self-reduction. Why? [QY-19]

Decomposition temperature of Ag_2O and HgO are 600 and 700K respectively.

These oxides are unstable at moderate temperatures undergo self reduction.

2. Name the collector and depressing agent used in froth flotation process. [HY-19]

- Sodium ethyl xanthate acts as a collector.
- Sodium cyanide, Sodium carbonate are used as depressing agents in froth flotation process.

3. How is metal purified by distillation method? Give example. [FRT-22]

This method is employed for low boiling volatile metals like zinc (boiling point 1180 K) and mercury (630 K). In this method, the impure metal is heated to evaporate and the vapours are condensed to get pure metal.

4. Explain how gold ore is leached by cyanide process. [GMQP-19, FMT-22, FUT-23]

- Gold is usually found in native state.
- The leaching process is intended to concentrate the gold metal.

$$4Au\,(s) + 8CN^-\,(aq) + O_2\,(g) + 2H_2O\,(l) \longrightarrow 4[Au(CN)_2]^-\,(aq) + 4OH^-(aq)$$

$$Zn\,(s) + 2[Au(CN)_2]^-\,(aq) \longrightarrow [Zn(CN)_4]^{-2}(aq) + 2Au\,(s)$$

- In this reaction, gold is reduced to its elemental state and the process is called cementation.

5. Write a note on gravity separation method. [FRT-22, MAY-22]

- Gravity separation method, the ore having high specific gravity is separated from the gangue that has low specific gravity by simply washing with running water.
- Ore is crushed to a finely powdered form and treated with rapidly flowing current of water.
- During this process the lighter gangue particles are washed away by the running water.
- This method is generally applied to concentrate the native ore such as gold and oxide ores such as haematite (Fe_2O_3), tin stone (SnO_2)

6. How is acid leaching done for the sulphide ores? (or) Explain Acid Leaching with an example. [JULY-22, HY-23]

- Leaching of sulphide ores such as ZnS, PbS etc., can be done by treating them with hot aqueous sulphuric acid.

$$2ZnS\,(s) + 2H_2SO_4\,(aq) + O_2(g) \longrightarrow 2ZnSO_4\,(aq) + 2S\,(s) + 2\,H_2O$$

- In this process the insoluble sulphide is converted into soluble sulphate and elemental sulphur.

7. In metallurgy roasting of ore is done below its melting points whereas smelting is done above its melting point. Why? [QY-19]

Roasting: Roasting is the method the sulphide ore is converted into oxide ore below its melting only it exist in solid.

Smelting: Smelting is a chemical substance that forms an easily fusible slag with gangue.

8. What are the main observation of Ellingham diagram? [QY-19]

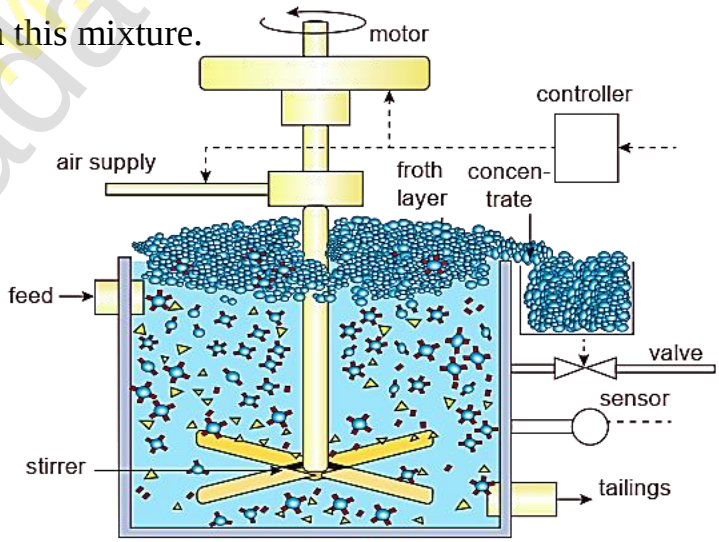
- For most of the metal oxide formation, the slope is positive. It can be explained as follows. Oxygen gas is consumed during the formation of metal oxides which results in the decrease

in randomness. Hence, ΔS becomes negative and it makes the term, TΔS positive in the straight line equation.

- The graph for the formation of carbon monoxide is a straight line with negative slope. In this case ΔS is positive as 2 moles of CO gas is formed by the consumption of one mole of oxygen gas. It indicates that CO is more stable at higher temperature.
- As the temperature increases, generally ΔG value for the formation of the metal oxide become less negative and becomes zero at a particular temperature. Below this temperature, ΔG is negative and the oxide is stable and above this temperature ΔG is positive. This general trend suggests that metal oxides become less stable at higher temperature and their decomposition becomes easier.
- There is a sudden change in the slope at a particular temperature for some metal oxides like MgO, HgO. This is due to the phase transition (melting or evaporation).

9. Explain froth flotation, with diagram. [JUL-21, FRT-23, SRT-24]

- Froth flotation method is commonly used to concentrate sulphide ores such as galena (PbS), zinc blende (ZnS) etc...
- In this method, the metallic ore particles which are preferentially wetted by oil can be separated from gangue.
- In this method, the crushed ore is suspended in water and mixed with frothing agent such as pine oil, eucalyptus oil etc.
- A small quantity of sodium ethyl xanthate which acts as a collector is also added.
- A froth is generated by blowing air through this mixture.
- The collector molecules attach to the ore particle and make them water repellent.
- As a result, ore particles, wetted by the oil, rise to the surface along with the froth.
- The froth is skimmed off and dried to recover the concentrated ore.
- The gangue particles that are preferentially wetted by water settle at the bottom.



10. What is auto reduction? [HY-22, FRT-22, FRT-23]

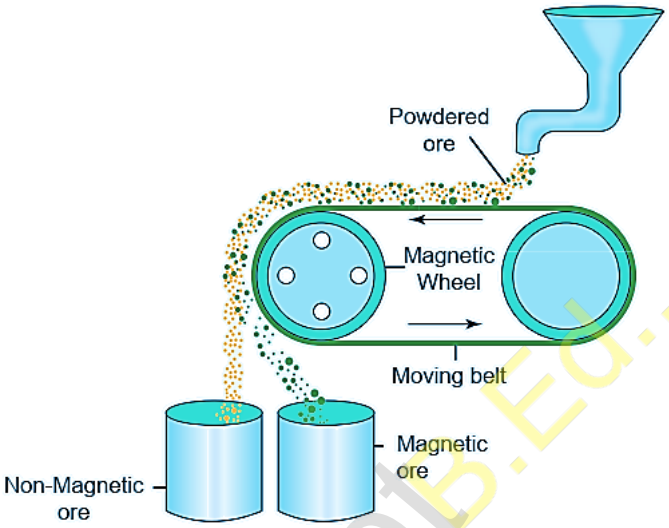
Simple roasting of some of the ores give the crude metal. In such cases, the use of reducing agents is not necessary. For example, mercury is obtained by roasting of its ore cinnabar (HgS)

$$HgS\,(s) + O_2\,(g) \longrightarrow Hg\,(l) + SO_2\uparrow$$

11. How are ores concentrated by magnetic separation method? [HY,FRT-22]

- Magnetic separation method is applicable to ferromagnetic ores and it is based on the difference in the magnetic properties of the ore and the impurities.
- For example tin stone can be separated from the wolframite impurities which is magnetic.

- Similarly, ores such as chromite, pyrolusite having magnetic property can be removed from the non magnetic siliceous impurities. The crushed ore is poured on to an electromagnetic separator consisting of a belt moving over two rollers of which one is magnetic.
- The magnetic part of the ore is attracted towards the magnet and falls as a heap close to the magnetic region while the nonmagnetic part falls away from it as shown in the figure



12. What is chemical leaching? [FRT-22]

- This method is based on the solubility of the ore in a suitable solvent and the reactions in aqueous solution.
- In this method, the crushed ore is allowed to dissolve in a suitable solvent, the metal present in the ore is converted to its soluble salt or complex while the gangue remains insoluble.

13. What type of oxidation process is employed for $CaCO_3$? Explain it. (or) What is Calcination? [FMT-22, APR-24]

Calcination is the process in which the concentrated carbonate ore is strongly heated in the absence of air. During calcination of carbonate ore, carbon dioxide is expelled

$$CaCO_3 \longrightarrow CaO + CO_2\uparrow$$

14. What are uses of Aluminium? [FMT-22, FRT-23]

- Many heat exchangers/sinks and our day to day cooking vessels are made of aluminium.
- It is used as wraps (aluminium foils) and is used in packing materials for food items,
- Aluminium is not very strong, However , its alloys with copper, manganese, magnesium and silicon are light weight and strong and they are used in design of aeroplanes and other forms of transport.
- As Aluminium shows high resistance to corrosion, it is used in the design of chemical reactors, medical equipments, refrigeration units and gas pipelines.
- Aluminium is a good electrical conductor and cheap, hence used in electrical overhead electric cables with steel core for strength.

15. In Ellingham diagram, the slope is positive for most of the metal oxide formation. Justify. [FMT-22]

Oxygen gas is consumed during the formation of metal oxides which results in the decrease in randomness. Hence, ΔS becomes negative and it makes the term, $T\Delta S$ positive in the straight line equation. So, most of the metal oxide formation in Ellingham diagram, the slope is positive.

16. Write about the liquation process. [JUN-23]

Liquation is a metallurgical technique to separate metals from an ore, metal or alloy. This is done by heating the material until one of the constituents starts melting and the other remains solid. The liquid melt is drained away from the other and collected. Earlier, it was used to

extract antimony minerals from ore. It is also used to remove lead containing silver from copper.

17. Explain Van-Arkel method for refining Titanium. (or) Explain how Zr and Ti are refined by Van-Arkel method. [HY-22, FRT-23]

- This method is based on the thermal decomposition of metal compounds which lead to the formation of pure metals. Titanium and zirconium can be purified using this method.
- For example, the impure titanium metal is heated in an evacuated vessel with iodine at a temperature of 550 K to form the volatile titanium tetra-iodide.(TiI_4). The impurities are left behind, as they do not react with iodine. $Ti\,(s) + 2I_2\,(s) \xrightarrow[\Delta]{550K} TiI_4\,(vapour)$
- The volatile titanium tetraiodide vapour is passed over a tungsten filament at a temperature aroud 1800 K. The titanium tetraiodide is decomposed and pure titanium is deposited on the filament. The iodine is reused. $TiI_4\,(vapour) \xrightarrow[\Delta]{1800\,K} Ti\,(s) + 2I_2\,(s)$

Zirconium: $Zr\,(impure) + 2I_2 \xrightarrow{523\,K} ZrI_4$ $\qquad$ $ZrI_4 \xrightarrow{1800K} Zr\,(pure) + 2I_2$

18. Write any four refining methods of crude metal. [FRT-23]

Distillation, Liquation, Electrolytic refining, Zone Refining, Vapour phase method (Mond process for refining nickel, Van-Arkel method for refining zirconium/titanium)

19. What is meant by cementation? [FRT-22]

Gold can be recovered by reacting the deoxygenated leached solution with zinc. In this process the gold is reduced to its elemental state (zero oxidation sate) and the process is called **cementation**. $Zn\,(s) + 2[Au(CN)_2]^-\,(aq) \longrightarrow [Zn(CN)_4]^{-2}(aq) + 2Au\,(s)$

20. What is Roasting? Given an example. [FRT-24]

Roasting is the method, usually applied for the conversion of sulphide ores into their oxides. In this method, the concentrated ore is oxidised by heating it with excess of oxygen in a suitable furnace below the melting point of the metal.

$2PbS + 3O_2 \xrightarrow{\Delta} 2PbO + 2SO_2\uparrow$ $\qquad$ $2ZnS + 3O_2 \xrightarrow{\Delta} 2ZnO + 2SO_2\uparrow$

21. What is blister copper? [FRT-24]

The copper sulphide is oxidised to its oxide which is subsequently converted to metallic copper as shown below.

$$2Cu_2S\,(l,s) + 3O_2\,(g) \longrightarrow 2Cu_2O\,(l,s) + 2SO_2\,(g)$$
$$2Cu_2O\,(l) + Cu_2S\,(l) \longrightarrow 6Cu\,(l) + SO_2\,(g)$$

The metallic copper is solidified and it has blistered appearance due to evolution of SO_2 gas formed in this process. This copper is called blister copper.

22. Explain Aluminothermic process. [FRT-24]

Metallic oxides such as Cr_2O_3 can be reduced by an aluminothermic process. In this process, the metal oxide is mixed with aluminium powder and placed in a fire clay crucible. To initiate the reduction process,

$$Cr_2O_3 + 2Al \xrightarrow{\Delta} 2Cr + Al_2O_3$$