

5. METALLURGY

SYNOPSIS

The compound of a metal found in nature is called a mineral. The minerals from which metal can be economically and conveniently extracted are called ores.

Metal	Ores	Composition
Aluminium	Bauxite	$\text{AlO}_x(\text{OH})_{3-2x}$ [where $0 < X < 1$] Al_2O_3
	Diaspore	$\text{Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$
	Corundum	Al_2O_3
	Kaolinite (a form of clay)	$[\text{Al}_2(\text{OH})_4\text{Si}_2\text{O}_5]$
Iron	Haematite	Fe_2O_3
	Magnetite	Fe_3O_4
	Siderite	FeCO_3
	Iron pyrite	FeS_2
	Limonite	$\text{Fe}_2\text{O}_3, 3\text{H}_2\text{O}$
Copper	Copper pyrite	CuFeS_2
	Copper glance	Cu_2S
	Cuprite	Cu_2O
	Malachite	$\text{CuCO}_3, \text{Cu}(\text{OH})_2$

Metallurgy :

The isolation and extraction of metals from their ores involve the following major steps :

- a) Crushing of the ore
- b) Dressing or concentration of the ore.
- c) isolation of the crude metal from its ore
- d) Purification or refining of the metal.

Crusing and Grinding

Concentration : The removal of unwanted useless impurities from the ore is called dressing, concentration or benefaction of ore.

(i) **Hydraulic washing or Gravity Separation or Levigation Method :**
used for the concetration of oxide and native ores.

(ii) **Electromagnetic Separation :** cassiterite ore (SnO_2) is separated from magnetic Wolframite ($\text{FeWO}_4 + \text{MnWO}_4$)

(iii) **Froth floatation process.** used for the concentration of the low grade sulphide ores like galena, PbS ; copper iron pyrites $\text{Cu}_2\text{S}, \text{Fe}_2\text{S}_3$.

It is based on the different degree of wettability with water and pine oil

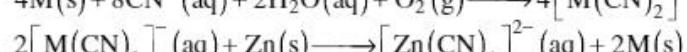
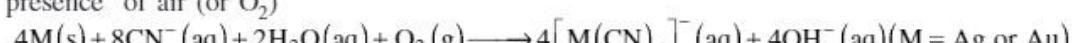
(a) **Frothers.** pine oil, camphor oil

(b) **Collectors.** Potassium or sodium ethyl xanthate

(iv) **Leaching :** Leaching is often used if the ore is soluble in some suitable solvent

Ex. Bauxite ore is leached with NaOH

In the metallurgy of silver and gold, ore is leached with a dilute solution of NaCN or KCN in the presence of air (or O_2)

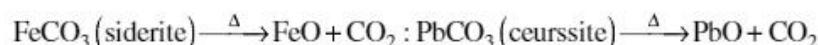


Extraction of Crude metal From concentrated ore :

(i) Conversion to oxide :

Calcination: It is a process of heating the concentrated ore strongly in a limited supply of air or in the absence of air.

(a) the carbonate ore gets decomposed to form the oxide of the metal, e.g.,



(b) Water of crystallisation present in the hydrated oxide ore gets lost as moisture, e.g.,



Roasting: It is a process of heating the concentrated ore (generally sulphide ore) strongly in the excess of air or O₂ below its melting point.

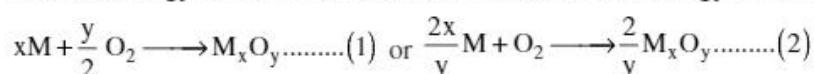


(iii) Reduction of a metal oxide :

The free metal is obtained by reduction of a compound. Using either a chemical reducing agent or electrolysis.

THERMODYNAMICS OF EXTRACTION : ELLINGHAM DIAGRAM OF A METAL

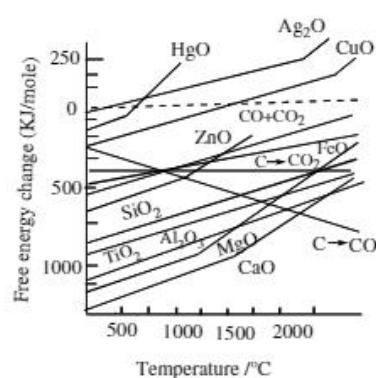
The free energy of formation ΔG is the standard free energy of the reaction.



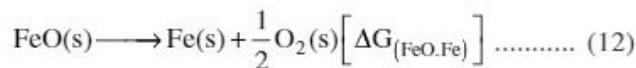
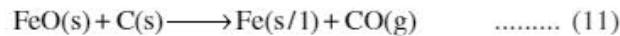
ΔG is the free energy of formation per mole of O₂ consumed.

If the standard free energy of formation ΔG has a negative sign at a given temperature, then the oxide can be expected to form spontaneously from the metal plus oxygen.

$$\Delta G = \Delta H - T\Delta S \dots\dots\dots(3)$$



Extraction of iron from ore haematite : Oxide ores of iron, after concentration through calcination / roasting in reverberatory furnace are mixed with lime stone and coke and fed into a Blast furnace. One of the main reduction steps in this process is :



In the Blast furnace, reduction of iron oxides takes place in different temperature ranges. At 500–800 K (lower temperature range in the blast furnace)



At 900–1500 K (higher temperature range in the blast furnace):



Limestone is also decomposed to CaO which removes silicate impurity of the ore as slag. The slag is molten state and separates out from iron.

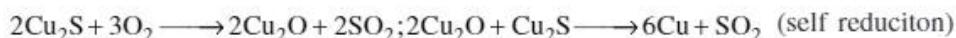
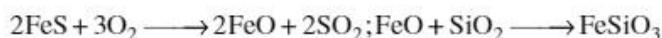
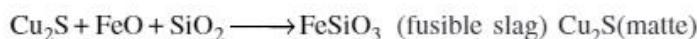
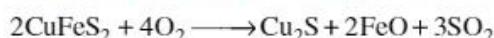


The iron obtained from blast furnace contains about 4% carbon. This is known as pig iron. Cast iron is made by melting pig iron with scrap iron and coke.

Wrought iron or malleable iron is the purest form of commercial iron

2. Extraction of Copper :

From copper glance / copper pyrite (self reduction) :



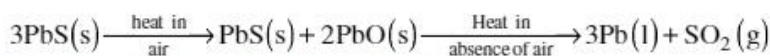
The solidified copper obtained has blistered appearance due to the evolution of SO₂ and so it is called blister copper.

3. Extraction Of Lead :

(i) Roast in air to give PbO, and then reduce with coke or CO in blast furnace.



(ii) self reduction method



4. Extraction Of Zinc From Zinc Blende :

The ore is roasted in presence of excess of air at temperature 1200 K.



The reduction of zinc oxide is done using coke.



The metal is distilled off and collected by rapid chilling

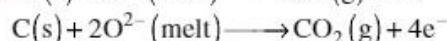
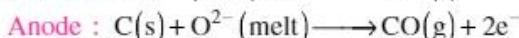
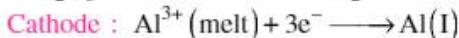
Extraction Of Aluminium: It involves the following processes

(a) Purification of bauxite :

(I) Byer's Method	(II) Hall's Method	(III) Serpeck's Method
(use for red bauxite containing Fe_2O_3 and silicates as impurities)	(used for red bauxite containing Fe_2O_3 and silicates as impurities)	(used for white bauxite containing silica as impurities)
$\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O} + 2\text{NaOH} \xrightarrow[8\text{ atm}]{190^\circ\text{C}} \text{Fe}_2\text{O}_3$ 2NaAlO_2 (soluble) + $3\text{H}_2\text{O}$	$\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O} + \text{Na}_2\text{CO}_3 \xrightarrow{\text{Fuse}}$ 2NaAlO_3 (soluble) + $\text{CO}_2 + 2\text{H}_2\text{O}$	$\text{Al}_2 \cdot 2\text{H}_2\text{O} + 3\text{C} + \text{N}_2 \xrightarrow[1800^\circ\text{C}]{\text{Electric furnace}}$
Fe_2O_2 insoluble separated as red mud by filtration solution is diluted with water and seeded with freshly prepared Al(OH)_3 is filtered leaving behind silicates solution $\text{NaAlO}_2 + 2\text{H}_2\text{O} \rightarrow \text{NaOH} + \text{Al(OH)}_3 \downarrow$ $2\text{Al(OH)}_3 \xrightarrow{1473\text{K}} \text{Al}_2\text{O}_3 + 3\text{H}_2\text{O}$	$2\text{NaAlO}_2 + 3\text{H}_2\text{O} + \text{CO}_2 \xrightarrow{60^\circ\text{C}}$ $2\text{Al(OH)}_3 \downarrow \text{Na}_2\text{CO}_3$ $2\text{Al(OH)}_2 \xrightarrow{1473\text{K}} \text{Al}_2\text{O}_3 + 3\text{H}_2\text{O}$	$2\text{AlN} + 3\text{CO} + 2\text{H}_2\text{O}$ $2\text{AlN} + 3\text{H}_2\text{O} \rightarrow \text{Al(OH)}_3 \downarrow + \text{NH}_3$ $\text{SiO}_2 + 2\text{CO} \rightarrow 2\text{CO}_3 + \text{Si}$ Silicone volatilizes at this temp $2\text{Al(OH)}_3 \xrightarrow{1473\text{K}} \text{Al}_2\text{O}_3 + 3\text{H}_2\text{O}$

(b) Electrolytic reduction (Hall-Heroult Process) :

The purified Al_2O_3 is mixed with Na_3AlF_6 (cryolite) or CaF_2 (fluorspar which lowers the melting point of the mixture and brings conductivity. Steel cathode and graphite anode are used.



PURIFICATION OR REFINING OF METALS :

Physical Methods :

(I) LIQUATION PROCESS : Used for the purification of Sn and Zn

(II) DISTILLATION PROCESS : Used to purify Zn, Cd and Hg.

III) Zone refining method: Used to purify Ge, Si, Ga, etc.,

(IV) CHROMATOGRAPHIC METHODS

Chemical Methods :

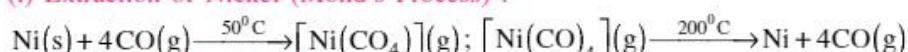
(I) OXIDATIVE REFINING :

(II) POLING PROCESS : Molten copper left behind contains CuO as impurity. This molten copper is treated with powdered anthracite and then stirred with a pole of green wood. Green wood, at high temperature, liberates hydrocarbon gases,

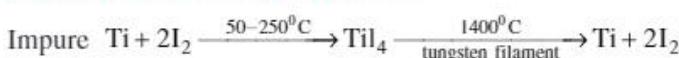
(III) ELECTROLYTIC REFINING : Anode is impure metal cathode is pure metal and electrolyte is molten salt. After electrolysis 99.99% pure metal is obtained

(IV) VAPOUR PHASE REFINING :

(i) EXTRACTION OF NICKEL (Mond's Process) :



(ii) VAN ARKEL-DE BOER PROCESS :



Uses :

(a) Copper is used for making wires used in electrical industry and for water and steam pipes.

(b) coinage alloy (Cu + Ni) (c) Zinc is used for galvanising iron.

 **LECTURE SHEET** 
 **EXERCISE-I** 

(General principles)

LEVEL-I (MAIN)***Straight Objective Type Questions***

1. Malachite and azurite are ____ ores of copper
 - 1) oxide
 - 2) carbonate
 - 3) sulphide
 - 4) silicate
2. Which of the following is not found in native state?
 - 1) Pt
 - 2) Cu
 - 3) Au
 - 4) Na
3. The process of removing lighter gangue particles by washing in a current of water is called
 - 1) Levigation (or) gravity separation
 - 2) Liquation
 - 3) Leaching
 - 4) Cupellation
4. The rocky and silicious matter associated with an ore is called
 - 1) Slag
 - 2) Mineral
 - 3) Matrix or Gangue
 - 4) Flux
5. Copper pyrites ore is concentrated by
 - 1) Electromagnetic method
 - 2) Gravity separation method
 - 3) Froth floatation method
 - 4) All the above methods
6. Which one of the following is not a method of concentration of ore
 - 1) gravity separation
 - 2) froth floatation process
 - 3) electromagnetic separation
 - 4) smelting
7. Gravity separation method is based upon
 - 1) Preferential washing of ores and gangue particles
 - 2) Difference in densities of ore particles and impurities
 - 3) Difference in chemical properties of ore particles and impurities
 - 4) None of these
8. Carbonate or hydroxide ores are generally converted to their oxides by
 - 1) Roasting
 - 2) Calcination
 - 3) Smelting
 - 4) Fluxing
9. In the froth floatation process for the purification of minerals the particles float because
 - 1) they are light
 - 2) they are insoluble
 - 3) their surface is preferentially wetted by oil
 - 4) they bear an electrostatic charge
10. Which of the following equation represents smelting process
 - 1) $\text{ZnCO}_3 \xrightarrow{\Delta} \text{ZnO} + \text{CO}_2$
 - 2) $2\text{PbS} + 3\text{O}_2 \xrightarrow{\Delta} 2\text{PbO} + 2\text{SO}_2$
 - 3) $\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O} \xrightarrow{\Delta} \text{Al}_2\text{O}_3 + 3\text{H}_2\text{O}$
 - 4) $\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Fe} + 3\text{CO}$

Numerical Value Type Questions

11. In the Auto oxidation taking place in Bessemer converter during the extraction of copper. The change in oxidation state of sulphur in this process is
12. How many metals are commercially extracted by pyrometallurgy from the given metals ?
Cu, Fe, Sn, Au, K, Na
13. Find the number of metals which are commercially reduced by self-reduction from the given metals
Fe, Al, Zn, Sn Pb, Hg, Cu

LEVEL-II (ADVANCED)Straight Objective Type Questions

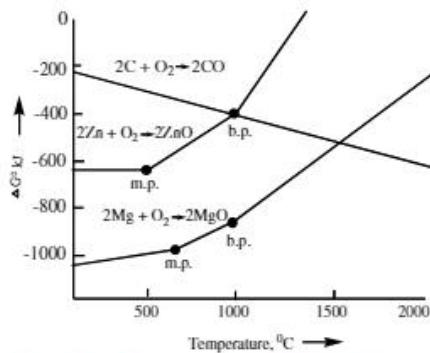
1. Froth flotation process for the concentration of ores is an illustration of the practical application of
 - a) Adsorption
 - b) Absorption
 - c) Coagulation
 - d) Sedimentation
2. Wolframite (FeWO_4) is separated from cassiterite by
 - a) Froth flotation method
 - b) Levigation
 - c) Electromagnetic method
 - d) Electrostatic separation method.
3. Which of the following metals is leached by cyanide process
 - a) Al
 - b) Na
 - c) Ag
 - d) Mg
4. If a metal has low oxygen affinity then the purification of metal may be carried out by:
 - a) liquation
 - b) distillation
 - c) zone refining
 - d) cupellation
5. Which of the following pair is incorrectly matched?
 - a) van Arkel method - Zirconium
 - b) Kroll's process - Titanium
 - c) Froth Floatation – Cerussite
 - d) Distillation - Zinc

More than One correct answer Type Questions

6. Which of the following processes involves the roasting process :
 - a) $\text{ZnS} + 3\text{O}_2 \longrightarrow 2\text{ZnO} + 2\text{SO}_2$
 - b) $\text{Fe}_2\text{O}_3 + 3\text{C} \longrightarrow 2\text{Fe} + 3\text{CO}$
 - c) $2\text{PbS} + 3\text{O}_2 \longrightarrow 2\text{PbO} + 2\text{SO}_2$
 - d) $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O} \longrightarrow \text{Al}_2\text{O}_3 + 2\text{H}_2\text{O}$
7. Hydrometallurgy is useful in the extraction of :
 - a) Sn
 - b) Al
 - c) Au
 - d) Ag
8. The ore concentrated by electromagnetic separation is :
 - a) Wolframite
 - b) Haemetite
 - c) Cassiterite
 - d) Rock salt
9. The extraction of metals from oxide ores involve
 - a) Reduction with carbon
 - b) Reduction with aluminium
 - c) Electrolyte reduction
 - d) Reduction with CO.
10. Roasting is carried out to
 - a) convert sulphide to oxide and sulphate
 - b) remove water of hydration
 - c) melt the ore
 - d) remove arsenic and sulphur impurities

Linked 7Comprehension Type QuestionsPassage - I:

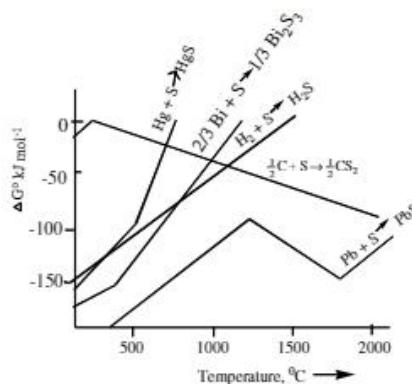
The Ellingham diagram for zinc, magnesium and carbon converting into corresponding oxides is shown below



11. At what temperature, zinc and carbon have equal affinity for oxygen ?
 - a) 1000^0C
 - b) 1500^0C
 - c) 500^0C
 - d) 1200^0C
12. To make the following reduction process spontaneous, temperature should be
 $\text{ZnO} + \text{C} \longrightarrow \text{Zn} + \text{CO}$
 - a) 1000^0C
 - b) $> 1100^0\text{C}$
 - c) $< 500^0\text{C}$
 - d) $< 1000^0\text{C}$
13. At 1100^0C , which reaction is spontaneous to a maximum extent ?
 - a) $\text{MgO} + \text{C} \rightarrow \text{Mg} + \text{CO}$
 - b) $\text{ZnO} + \text{C} \rightarrow \text{Zn} + \text{CO}$
 - c) $\text{MgO} + \text{Zn} \rightarrow \text{Mg} + \text{ZnO}$
 - d) $\text{ZnO} + \text{Mg} \rightarrow \text{MgO} + \text{Zn}$

Passage - II :

The Ellingham diagram for a number of metallic sulphides is shown below



14. Formation of which of the sulphides is most spontaneous ?
 - a) HgS
 - b) Bi_2S_3
 - c) PbS
 - d) CS_2
15. Which sulphide occurs to minimum extent in nature ?
 - a) HgS
 - b) H_2S
 - c) Bi_2S_3
 - d) CS_2
16. Which of the following sulphides can not be reduced to metal by H_2 at about 1000^0C ?
 - a) HgS
 - b) PbS
 - c) Bi_2S_3
 - d) all of these

Matrix Matching Type Questions**17. Column-I**

- A) Felspar
B) Asbestos
C) Pyrargyrite
D) Diaspore

Column-II

- p) $[Ag_3SbS_3]$
q) $Al_2O_3 \cdot H_2O$
r) $MgSO_4 \cdot H_2O$
s) $KAlSi_3O_8$
t) $CaMg_3(SiO_3)_4$

18. Column-I (Type of mineral)

- A) Oxide
B) Carbonate
C) Sulphide
D) Silicate

Column-II

- p) Kaolinite
q) Calamine
r) Copper glance
s) Cuprite

19. Column-I

- A) vanArkel method
B) Solvay process
C) Cupellation
D) Poling

Column-II

- p) Manufacture of caustic soda
q) Purification of Titanium
r) Manufacture of Na_2CO_3
s) Purification of copper
t) Refining of silver

Integer Type Questions

20. How many of the following are oxide ores. Calamine, Cuprite, Zincite, Chalcocite, Haematite, Bauxite, Magnetite, Caesiterite
21. How many of the following are silver ores
a) Chlorargirite b) Argentite c) Pyrargyrite d) Azurite e) Calamine
22. Ores of how many of the following metals can be treated by carbon reduction or self reduction to obtain metal? Cu, Pb, Sn, Zn, Al, Ag, Na

EXERCISE-II

(Iron, copper, zinc, Tin lead)

LEVEL-I (MAIN)***Straight Objective Type Questions***

1. Most abundant ore of iron is
1) magnetite 2) haematite 3) limonite 4) pyrites
2. The reducing agent added in the extraction of Iron from oxide ore of iron is
1) coke 2) Aluminium 3) carbon monoxide 4) zinc
3. In the middle part of blast furnace, iron ore is treated with lime stone to remove
1) C 2) CaO 3) SiO_2 4) Fe_2O
4. The iron obtained from blast furnace is
1) Pig iron 2) Silver 3) Soft iron 4) Steel

5. In which of the following percentage of carbon is maximum
 1) Pig iron 2) Cast iron 3) Wrought iron 4) Pig iron and wrought iron
6. Which is the chief ore of copper ?
 1) Galena 2) Copper pyrites 3) Sphalerite 4) Siderite
7. The matte obtained in the metallurgy of copper has the approximate Composition
 1) FeS + CuO 2) Cu₂S + FeO 3) Cu₂S + FeS 4) CuS + FeS₂
8. The chemical composition of 'slag' formed during smelting process in the extraction of copper in
 1) Cu₂O +FeS 2) FeSiO₃ 3) CuFeS₂ 4) Cu₂S+FeO
9. Heating mixture of Cu₂O and Cu₂ S will give
 1) Cu + SO₂ 2) Cu + SO₃ 3) CuO + CuS 4) Cu₂SO₃
10. Zinc is obtained on large scale by
 1) Electrolysis of ZnCl₂ 2) Reduction of ZnO
 3) Precipitation with Ag 4) Any of these methods
11. In Belgian process, for reduction of ZnO to Zn reductant is
 1) Al 2) Coal or Coke 3) H₂ 4) Water gas
12. Impurities in the zinc spelter are
 1) Ag and Au 2) Cd and Pd 3) Cd, Pb and As 4) Cd As and Au

Numerical Value Type Questions

13. In Goldschmidt aluminothermic process, thermite mixture contains x-parts of Fe₂O₃ and one part of aluminium x is
14. Howmany metals are commercially extracted by electrometallurgy from the given metals ?
 Al, Mg, Na, K, Ag, Hg, Ti, Th, Zr, B

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. Mark the wrong statement among the following. The iron ore after washing is roasted with a little coal in excess of air. During roasting
 a) moisture is removed b) S and As are removed in the form of their volatile oxides
 c) Any ferrous oxide is oxidised to ferric oxide
 d) The mass becomes compact and thus makes it suitable for ready reduction to metallic iron.
2. Roasted iron ore is mixed with coke and lime stone and smelted in blast furnace. Which among the following does not represent the correct answer about the reactions taking place in the blast furnace.
 a) In the lower part, called zone of fusion temperature (1773 K) coke burns to CO₂ producing 97000 calories of heat
 b) In the middle part, lime stone decomposes to give CO₂ and lime which acts as a reducing agent.
 c) In the middle part, of the furnace called zone of heat absorption (temperture 1073-1273 K) CO₂ is reduced to CO
 d) At the top is the zone of reduction (temperature 673-973 K). Here iron oxide is reduced to spongy iron by CO

More than One correct answer Type Questions

10. Which of the following reaction in the blast furnace is/are endothermic ?

 - a) $C_{(s)} + O_{2(g)} \rightleftharpoons CO_{2(g)}$.
 - b) $CO_{2(g)} + C_{(s)} \rightleftharpoons 2CO_{(g)}$.
 - c) $CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$.
 - d) $Fe_2O_{3(s)} + 3CO_{(g)} \rightleftharpoons 2Fe(l) + 3CO_{2(g)}$.

11. Which metal(s) is (are) volatile ?

 - a) Cu
 - b) Zn
 - c) Pb
 - d) Cd

12. During bessemerisation of copper, the reaction taking place in the bessemer converter is
 a) $\text{Cu}_2\text{S} + 2 \text{Cu}_2\text{O} \longrightarrow 6\text{Cu} + \text{SO}_2$ b) $\text{Cu}_2\text{O} + \text{FeS} \longrightarrow \text{Cu}_2\text{S} + \text{FeO}$
 c) $\text{FeO} + \text{SiO}_2 \longrightarrow \text{FeSiO}_3$ d) None of these
13. In which of the following processes, calcium silicate slag is formed. Extraction of
 a) Tin from cassiterite b) Copper from copper pyrite
 c) Zinc from Zinc blende d) Iron from haematite
14. In metallurgy, an ore may be dissolved in water and the element may be displaced from solution using another cheap element. An example for this
 a) Solution of Cd + Zn metal b) Sea water containing $\text{Br}_2 + \text{Cl}_2$
 c) Solution of Fe + Cu metal d) Solution of Zn + Ag metal
15. Metals which can be extracted by smelting process is/are
 a) Sn b) Cu c) Zn d) Al

Linked Comprehension Type Questions

Passage - I :

Copper is the most noble of first row transition metals and occurs in small deposits in several countries ores of copper include chalcanthite ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$), atacamite(CuCl(OH)_3), cuprite(Cu_2O), Copper glance(Cu_2S) and rolachite ($\text{Cu}_2(\text{OH})_2\text{CO}_3$). However, 80% of the world copper production comes from the ore chalcopyrite (CuFeS_2). The extraction of copper from chalopyrite involves partial roasting, removal of Iron self-reduction

16. Partial Roasting of chalcopyrite produces
 a) Cu_2S and FeO b) Cu_2O and FeO c) CuS and Fe_2O_3 d) Cu_2O and Fe_2O_3
17. Iron is removed from chalcopyrite as
 a) FeO b) FeS c) Fe_2O_3 d) FeSiO_3
18. In self reduction the reducing species is
 a) S b) O^{-2} c) S^{-2} d) SO_2

Matrix Matching Type Questions

- | | | | | | | | |
|---|---|---|---|--|--|--|--|
| <p>19. Column-I (ore)</p> <p>A) Malachite
 B) Siderite
 C) Sphalerite
 D) Kaolinite</p> | <p>Column-II (Metal)</p> <p>p) Cu
 q) Zn
 r) Fe
 s) Al</p> | | | | | | |
| <p>20. Various types of zone in the blast furnace are given in the List-I and reactions take place in the extraction of iron are given in List-II.</p> <table border="0" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; vertical-align: top;"> <p>Column-I</p> <p>A) Zone of reduction
 B) Zone of heat absorption
 C) Zone of fusion</p> </td> <td style="width: 50%; vertical-align: top;"> <p>Column-II</p> <p>p) $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$
 q) $\text{CO}_2 + \text{C} \rightarrow 2\text{CO}$
 r) $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$</p> </td> </tr> <tr> <td colspan="2"> <p>21. Column-I</p> <p>A) Iron and copper
 B) Zirconium and Titanium
 C) Lead and Tin
 D) Copper and Tin</p> </td> </tr> <tr> <td colspan="2"> <p>Column-II</p> <p>p) Poling
 q) Bessemerisation
 r) Van-Arkel
 s) Liquation</p> </td> </tr> </table> | | <p>Column-I</p> <p>A) Zone of reduction
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| <p>Column-II</p> <p>p) Poling
 q) Bessemerisation
 r) Van-Arkel
 s) Liquation</p> | | | | | | | |

Integer Type Questions

22. Galena $\xrightarrow{\text{roasting}}$ metal oxide + gas oxidation state of 's' in galena - oxidation state of 's' in product
23. How many metals are present in the ore chalcopyrite, from which 80% of the world's copper production comes

EXERCISE-III**(Sodium, Magnesium, Aluminium, Silver and Gold)****LEVEL-I (MAIN)**Straight Objective Type Questions

- The metal that occurs in the native state as well as in the combined form is
1) Silver 2) Magnesium 3) Aluminum 4) Manganese
- A common metal widely used in the displacement method to obtain other metals is
1) Cu 2) Fe 3) Zn 4) Ca
- From sodium argento cyanide $\text{Na}[\text{Ag}(\text{CN})_2]$, silver is precipitated by adding a powder of
1) Gold 2) Zinc 3) Mercury 4) Gold or Mercury
- The metal extracted by leaching with a cyanide is
1) Mg 2) Ag 3) Cu 4) Na
- The chemical reagent used for leaching of gold and silver ores is
1) Sodium hydroxide 2) Potassium cyanide 3) Potassium cyanate 4) Sodium sulphate
- Name the metal M, which is extracted based on the following equation
$$4\text{M} + 8\text{CN}^- + 2\text{H}_2\text{O} + \text{O}_2 \rightarrow 4[\text{M}(\text{CN})_2]^- + 4\text{OH}^-; 2[\text{M}(\text{CN})_2]^- + \text{Zn} \rightarrow [\text{Zn}(\text{CN})_4]^{2-} + 2\text{M}$$

1) Cu 2) Au (or) Ag 3) Hg 4) Ni
- Native silver metal forms a water soluble complex with a dilute aqueous solution of NaCN in the presence of
1) Nitrogen 2) Oxygen 3) Carbon dioxide 4) Argon
- Which of the following metals can be used for precipitation of silver from sodium argento-cyanide solution
1) Zn 2) Cu 3) Al 4) All
- The final step in the metallurgical extraction of Cu metal from Cu pyrites takes place in a Bessemer converter. The reaction taking place
1) $\text{Cu}_2\text{S} + \text{O}_2 \rightarrow 2\text{Cu} + \text{SO}_2$ 2) $4\text{Cu}_2\text{O} + \text{FeS} \rightarrow 8\text{Cu} + \text{FeSO}_4$
3) $2\text{Cu}_2\text{O} + 2\text{Cu}_2\text{S} \rightarrow 6\text{Cu} + \text{SO}_2$ 4) $\text{Cu}_2\text{S} + 2\text{FeO} \rightarrow 2\text{CuO} + 2\text{Fe} + \text{SO}_2$
- At high temperature the amount of sodium formed in the Castner process decreases due to
1) Sodium metal high density 2) Sodium metal dissolves in fused NaOH
3) High electrode potential 4) Low ionisation potential
- The substance added to NaCl in Down's process to lower the melting point of NaCl is
1) NaCl 2) K_2CO_3 3) CaCl_2 4) AlCl_3

12. In the Down's process at low temperature sodium extracted is more because
 1) Solubility of sodium metal in fused electrolyte is less
 2) Vapour pressure of sodium is more
 3) Solubility of sodium in fused state is high 4) Common salt is the electrolyte used
13. (A) : Magnesium metal can easily be extracted from sea water rather than sodium metal.
 (R) : $Mg(OH)_2$ is less soluble in water than NaOH.
 1) A and R are true, R explains A 2) A and R are true, R cannot explain A.
 3) A is true R is false 4) A is false R is true.
14. What is the reaction occurring at the anode in Down's process for the extraction of sodium? (2002)
 1) $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$ 2) $Na^+ + e^- \rightarrow Na$
 3) $2Cl^- \rightarrow Cl_2 + 2e^-$ 4) $NaOH \rightarrow Na^+ + OH$
15. Which one of the following electrolyte is used in Down's process of extracting sodium metal? (2003)
 1) $NaCl + KCl + KF$ 2) $NaCl$ 3) $NaOH + KCl + KF$ 4) $NaCl + NaOH$
16. In the Castner process for the extraction of sodium, the anode is made of ---- metal.
 1) Copper 2) Iron 3) Sodium 4) Nickel
17. The electrolyte used in castner's process of sodium extraction is
 1) Aqueous Na_2CO_3 2) Aqueous NaOH
 3) $NaCl + NaCl_2$ 4) Fused anhydrous NaOH
18. Of the following metals that cannot be obtained by electrolysis of the aqueous solution of their salts is /are
 1) Ag 2) Au 3) Cu 4) Al and Mg
19. (A) : In the extraction of Mg from fused anhydrous $MgCl_2$, air gap of the electrolytic cell is to be replaced by inert gas.
 (R) : Oxidation of Mg metal is to be prevented during its extraction by electrolytic reduction of anhydrous $MgCl_2$.
 1) A and R are true, R explains A 2) A and R are true, R cannot explain A.
 3) A is true R is false 4) A is false R is true.
20. Sea water contains Magnesium in the form of
 1) Carbonate 2) Chloride 3) Suphate 4) Both (2) & (3)
21. Magnesium metal is extracted from
 1) Carnallite 2) Magnesite 3) Sea water 4) All of these
22. Hydrated magnesium chloride on strong heating gives finally
 1) $MgCl_2$ 2) MgO 3) $Mg(OH)Cl$ 4) Mg_2OCl_2
23. On heating $MgCl_2 \cdot 2H_2O$ at $350^\circ C$ in the presence of anhydrous $MgCl_2$ is formed
 1) dry HCl 2) NaCl 3) SO_2 4) Air
24. In the Hansgig method of reduction of Magnesia with carbon, the backward reaction is prevented by quenching the mixture of magnesium vapour and carbon monoxide with
 1) HCl gas 2) CO gas 3) CaF_2 4) H_2

25. MgO can be reduced with
 1) Silicon 2) Ferro-Silicon 3) CaC₂ 4) All the above
26. In the Bayer's process of purification of red bauxite the leaching agent is
 1) concentrated caustic soda 2) Na₂CO₃
 3) NaCN 4) KCN
27. The electrolytic reduction method for the preparation of aluminium is called
 1) Hoop's process 2) Baeyer's process
 3) Hall and Heroult process 4) Serpeck process
28. The important byproduct in the purification of bauxite by Serpeck's process is
 1) HCl 2) N₂ 3) NH₃ 4) NO₂
29. The reaction not involved in the concentration of bauxite ore by Hall's process is
 1) Al₂O₃ + Na₂CO₃ → 2NaAlO₂ + CO₂ 2) 2NaAlO₂ + 3H₂O + CO₂ → 2Al(OH)₃ + Na₂CO₃
 3) 2Al(OH)₃ → Al₂O₃ + 3H₂O 4) AlN + 3H₂O → Al(OH)₃ + NH₃
30. In the electrolytic reduction of alumina, the anodic product is
 1) Al 2) Na 3) O₂ 4) H₂
31. The reagent and intermediate product in Halls process are
 1) NaOH, NaAlO₂ 2) Na₂CO₃, NaAlO₂ 3) N₂ + CO, NH₃ 4) NaOH, AlN

Numerical Value Type Questions

32. How many of the following are silver ores
 a) Chlorargirite b) Argentite c) Pyrargirite
 d) Azurite e) Calamine
33. Roasted gold ore + CN⁻ + H₂O + $\xrightarrow{\text{O}_2}$ x + OH⁻. What is the oxidation at 'Au' is complex 'x'

LEVEL-II (ADVANCED)***Straight Objective Type Questions***

1. In Castner's process the correct anodic reaction and the type of reaction occurs at anode is
 a) OH⁻ → H₂ + O₂, Reduction b) 4OH⁻ → 2H₂O₂ + O₂ 4e⁻, Oxidation
 c) 2OH⁻ → H₂ + O₂, Oxidation d) None
2. Which of the following is advisable & advantageous in reduction of low grade copper ores
 a) Gold b) Zinc scraps c) Iron scraps d) H⁺
3. Electrolytic process is used for the extraction of
 a) Alkali metal b) Alkaline earth metals c) Al d) All
4. In Goldsmith thermite process, element undergoing oxidation is
 a) Chromium b) Manganese
 c) Chromium and Manganese d) Aluminium
5. In the electrolysis of alumina, cryolite is added to :
 a) lower the melting point of alumina b) increase the electrical conductivity
 c) remove impurities from alumina d) both a and b

6. Which of the following contain(s) aluminium ?
 a) Feldspar b) Epson c) Fluorspar d) Flourite
7. Which of the following metal(s) cannot be obtained by electrolysis of their aqueous salt solutions ?
 a) Ag b) Mg c) Cu d) Zn
8. Silver is extracted by :
 a) Cupellation method b) Parke's process c) Pattinson's process d) All
9. $Al_2O_3 \rightarrow Al/N \rightarrow Al(OH)_3 \rightarrow Al_2O_3$. The sequence of these products involved in
 a) Bayer's process b) Serpeks process
 c) Hall's process d) Hooke's process
10. In the purification of bauxite by Hall's process
 a) The bauxite ore is heated with concentrated NaOH solution at 150^0C
 b) The bauxite ore is heated with $NaHCO_3$
 c) The bauxite ore is mixed with coke and heated at 1800^0C in a current of N_2
 d) The bauxite ore is fused with Na_2CO_3

More than One correct answer Type Questions

11. Electro metallurgical process (electrolysis of fused electrolyte) is employed to extract
 a) Iron b) Aluminium c) Silver d) Sodium
12. Electrolysis method is used for the extraction of
 a) Cu b) Fe c) Al d) Na
13. Electrolytic reduction is used in the extraction of
 a) Magnesium b) Sodium c) Aluminium d) Gold
14. In the extraction of which of the following metal's amalgamation process is used ?
 a) Ag b) Au c) Cu d) Fe
15. Which of the following is (are) extracted from sulphide ores ?
 a) Cu b) Ag c) Pb d) Zn
16. Ag is extracted by
 a) Cupellation method b) Parke's process
 c) Pattinson's process d) None of these
17. Which metal occurs in Free state ?
 a) Ag b) Au c) Pt d) Cu
18. Which of the following is(are) present in mica ?
 a) K b) Al c) Si d) Ca
19. Which is(are) ore(s) of aluminium ?
 a) Cryolite b) Bauxite c) Malachite d) Cuprite
20. Which one of the following metals can be extracted by aluminothermite process.
 a) Manganese b) Iron c) Chromium d) Magnesium

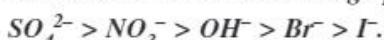
Linked Comprehension Type Questions

Passage - I :

Electrolysis is an important technique for extraction of metals and each ion of the solution needs a minimum voltage to get discharged and this value is expressed in terms of discharge potential. For some metal ions the discharge potentials follow the order given below :



For some anions the discharge potentials are in the order :



21. When aqueous solution of cuprous bromide is electrolysed the product obtained at cathode will be :
 a) Cu b) H₂ c) Br₂ d) O₂

22. The product formed at anode and cathode, when dilute H₂SO₄ is electrolysed are :
 a) SO₂, H₂ b) SO₃, H₂ c) H₂S₂O₈ d) O₂, H₂

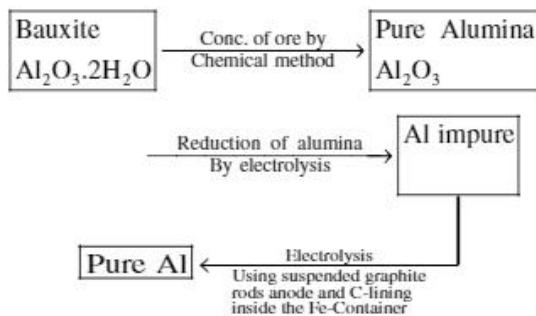
23. A mixture containing chlorides of sodium, calcium and zinc is electrolysed in presence of water.
 The product obtained at cathode will be :
 a) Na b) H₂ c) Ca d) Zn

24. When conc. H₂SO₄ is electrolysed with high current density using Pt electrodes, the product obtained at anode is :
 a) SO₂ b) SO₃ c) O₂ d) H₂S₂O₈

25. When aqueous NaCl is electrolysed by using Hg electrode, the product obtained at cathode is :
 a) Na-Hg amalgam b) Na c) H₂ d) Hg

Passage - II :

Extraction of Aluminium can be understood by :



Electrolytic reduction of Al_2O_3 :

Electrolyte : $(\text{Al}_2\text{O}_3 + \text{Cryolite})$

Cathode : Graphite inside the Fe container

Anode : Graphite rods

26. The purpose of adding cryolite is :

 - a) to increase the electrical conductivity of pure aluminium
 - b) to lower the melting point of Al_2O_3
 - c) to remove the impurities as slag
 - d) to increase the Al % in the yield.

27. Coke powder is spreaded over the molten electrolyte to :
- prevent the heat radiation lies from the surface
 - prevent the corrosion of graphite anode
 - prevent oxidation of molten aluminium by air
 - both (a) & (b)
28. The molten electrolytes contains Na^+ , Al^{3+} , Ca^{2+} but only Al gets deposited at cathode because :
- standard reduction potential of Al is more than those of Na & Ca
 - Standard oxidation potential of Al is more than those of Na & Ca
 - Discharge potential of Al^{3+} is higher than Na^+ & Ca^{2+}
 - Graphite reacts only with Al^{3+} and not with Na^+ & Ca^{2+} .

Matrix Matching Type Questions**29. Column-I**

- A) Magnesite
B) Dolomite
C) Corundum
D) Bauxite

Column-II

- p) Ore of magnesium
q) Ore of aluminium
r) Oxide ore
s) Carbonate ore

30. Column-I

- A) Mica
B) Felspar
C) Glauber's salt
D) China clay

Column-II

- p) KAlSi_3O_8
q) $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$
r) $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
s) $\text{K}_2\text{O} \cdot 3\text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2 \cdot 2\text{H}_2\text{O}$

Integer Type Questions

31. The oxidation state of Al in cryolite
32. Epsom salt is $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$. What is the value of 'x' in epsom salt
33. $\text{Ag}_2\text{S} + \text{NaCN} + \text{Zn} \longrightarrow \text{Ag} + \text{W}$

In 'W' the coordination number of Zn is

KEY SHEET (LECTURE SHEET)**EXERCISE-I**

LEVEL-I	1) 2 2) 4 3) 1 4) 3 5) 3 6) 4 7) 2 8) 2
	9) 3 10) 4 11) 6 12) 3 13) 3
LEVEL-II	1) a 2) c 3) c 4) d 5) c 6) ac 7) cd 8) abc
	9) abcd 10) ad 11) a 12) b 13) d 14) c 15) d 16) b
	17) A-s; B-t; C-p; D-q 18) A-s; B-q; C-r; D-p
	19) A-q; B-r; C-t; D-s 20) 6 21) 3 22) 4

EXERCISE-II

LEVEL-I	1) 2 2) 1 3) 3 4) 1 5) 1 6) 2 7) 3 8) 2
	9) 1 10) 2 11) 2 12) 3 13) 3 14) 4

LEVEL-II

- 1) d 2) b 3) a 4) d 5) b 6) d 7) b 8) c
 9) b 10) bc 11) bd 12) ac 13) ad 14) ab 15) bc 16) a
 17) d 18) c 19) A-p; B-r; C-q; D-s 20) A-r; B-q; C-p
 21) A-q; B-r; C-s; D-p 22) 6 23) 2

EXERCISE-III**LEVEL-I**

- 1) 1 2) 3 3) 2 4) 2 5) 2 6) 2 7) 2 8) 4
 9) 2 10) 2 11) 3 12) 1 13) 1 14) 3 15) 1 16) 4
 17) 4 18) 4 19) 1 20) 4 21) 4 22) 2 23) 1 24) 4
 25) 4 26) 1 27) 3 28) 3 29) 4 30) 3 31) 2
 32) 3 33) 1

LEVEL-II

- 1) b 2) c 3) d 4) d 5) d 6) a 7) b 8) d
 9) b 10) d 11) bd 12) cd 13) bc 14) ab 15) abcd 16) abc
 17) abcd 18) acd 19) ab 20) abc 21) a 22) d 23) b 24) d
 25) a 26) b 27) c 28) a 29) A-ps; B-ps; C-qr; D-qr
 30) A-s; B-p; C-r; D-q 31) 3 32) 7 33) 4

PRACTICE SHEET**EXERCISE-I***(General principles)***LEVEL-I (MAIN)****Straight Objective Type Questions**

- Which of the following is a foaming agent in froth-flotation process
 1) pine oil 2) amyl xanthate 3) CuSO_4 4) KCN
- Among the following statements the incorrect one is
 1) Calamine and siderite are carbonates 2) Argentite and cuprite are oxides
 3) Zine blende and iron pyrites are sulphides 4) Malachite and azurite are ores of copper
- The process of removing of lighter gangue particles by washing in a current of water is called
 1) levigation 2) liquation 3) leaching 4) cupellation
- Gravity separation process may be used for the concentration of
 1) Chalcopyrite 2) Bauxite 3) Haematite 4) Calamine

Numerical Value Type Questions

- During Aluminothermy one mole of Cr_2O_3 reduced to Cr. How many no.of the moles of Al are required
- In the hydrated chloride ($\text{MgCl}_2 \cdot x\text{H}_2\text{O}$) of Mg, the value of 'x' is

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. Which one of the following is used as conditioner in froth floatation process
 - a) Pine oil
 - b) Sodium ethyl xanthate
 - c) Sodium carbonate
 - d) Olive oil
2. Gravity separation method is based upon
 - a) preferential washing of ores and gangue particles
 - b) differences in densities of ore particles and impurities
 - c) differences in chemical properties of ore particles and impurities
 - d) none
3. The substance used as an activator in froth floatation process
 - a) Potassium ethyl xanthate
 - b) NaCN
 - c) CuSO₄
 - d) pine oil
4. Rutile is separated from chlorapatite by
 - a) Froth floatation method
 - b) levigation
 - c) electro magnetic separation method
 - d) electrostatic separation method
5. Identify x,y,z for the following metallurgical process
 Metal sulphide \xrightarrow{x} Metal oxide \xrightarrow{y} Impure metal \xrightarrow{z} pure metal
 - a) Roasting, reduction, electrolysis
 - b) Roasting calcination smelting
 - c) Roasting, auto-reduction, Bessemerization
 - d) None of the above is correct
6. One of the processes used for concentration of ores is froth floatation process. This process is generally used for concentration of sulphide ores. Sometimes in this process we add NaCN as a depressant. NaCN is generally added in case of ZnS and PbS minerals. What is the purpose of addition of NaCN during the process of froth floatation?
 - a) NaCN causes reduction by precipitation
 - b) A soluble complex is formed by reaction between NaCN and ZnS while PbS forms froth
 - c) A soluble complex is formed by reaction between NaCN and PbS while ZnS forms froth
 - d) A precipitate of Pb(CN)₂ is produced while ZnS remains unaffected
7. Which is not correct statement
 - a) Cassiterite, Chromites and pitch blende are concentrated by hydraulic washing
 - b) Pure Al₂O₃ is obtained from the bauxite ore by leaching in the Baeyer's process
 - c) Sulphide ore is concentrated by calcination method
 - d) Roasting can convert sulphide into oxide or sulphate and part of sulphide may also act as reducing agent

More than One correct answer Type Questions

8. Which of the following process makes the ore porous ?
 - a) Roasting
 - b) Calcination
 - c) Reduction
 - d) Distillation
9. Froth floatation :
 - a) is a physical method of separating mineral from the gangue
 - b) is a method to concentrate the ore depending on the difference in wetability of gangue and the ore
 - c) is used for the sulphide ores
 - d) is a method in which impurities sink to the bottom.

10. The disadvantages of carbon reduction method are :

- high temperature needed which is expensive and requires the use of a blast furnace
- many metals combine with carbon forming carbides
- carbon combines with oxygen to form poisonous CO
- carbon cannot be used with highly electro-positive metals.

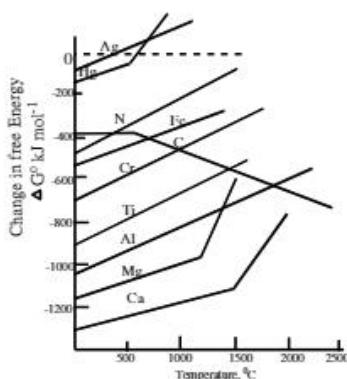
Linked Comprehension Type Questions

Passage - I :

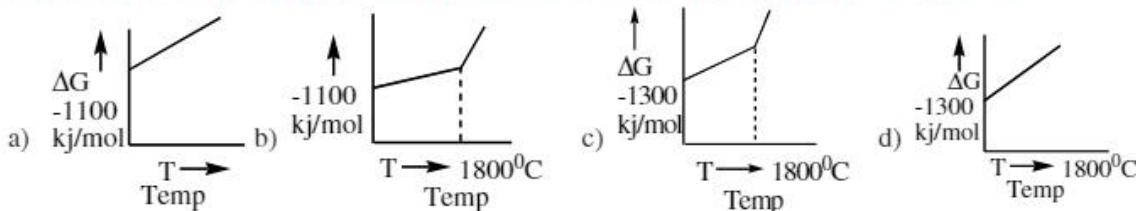
For a spontaneous reaction, the free energy change must be negative. $\Delta G = \Delta H - T\Delta S$, ΔH is the enthalpy change during the reaction. T is absolute temperature, and ΔS is the change in entropy during the reaction. Consider a reaction such as the formation of an oxide



Dioxygen is used up in the course of this reaction. Gases have a more random structure (less ordered) than liquid or solids. Consequently gases have a higher entropy than liquids and solids. In this reaction S (entropy or randomness) decreases, hence ΔS is negative. Thus, if the temperature is raised then $T\Delta S$ becomes more negative. Since, $T\Delta S$ is subtracted in the equation, then ΔG becomes less negative. Thus, the free energy changes increase with the increase in temperature. The free energy changes that occur when one mole of common reactant (in this case dioxygen) is used may be plotted graphically against temperature for a number of reactions of metals to their oxides. The following plot is called an Ellingham diagram for metal oxides. Understanding of Ellingham diagram is extremely important for the efficient extraction of metals.



11. For the conversion of Ca(s) to CaO(s) which of the following represent the ΔG vs. T :



12. Free energy change of Hg and Mg for the conversion to oxides the slope of ΔG vs. T has been changed above the boiling points of the given metal because

- above the boiling point of the metal entropy is increased
- above the boiling point of the metal the entropy is decreased
- above the boiling point of the metal the entropy change is equal to zero
- All of these

13. Which of the following elements can be prepared by heating the oxide above 400°C ?

- a) Hg b) Mg c) Fe d) Al

14. As per the Ellingham diagram of oxides which of the following conclusion is true ?

- a) Al reduces Fe_2O_3 , whereas MgO cannot be reduced by Al at 1500°C
 b) Fe reduces Al_2O_3 , whereas MgO cannot be reduced by Al at 1500°C
 c) Al reduces Fe_2O_3 , whereas MgO cannot be reduced by Ca at 1500°C
 d) Al can reduce both Fe_2O_3 and MgO to the corresponding metal at 1500°C

Passage - II :

The heating process for the extraction of elements are quite old but highly acceptable method for the extraction of elements. Because in this process the elements produced is in the highly pure state. Mostly As, Sb, N₂, Ni, Zr, B etc are prepared by this principle. A number of metal sulphides which may be roated first in air to partially convert them to the oxide, and then further roasted in the absence of air, causing self reduction.

15. How does impure Ni is purified ?

- a) impure Ni + $\text{CO}_2 \xrightarrow{\Delta} \text{NiCO}_3 \xrightarrow{\Delta} \text{NiO} + \text{CO}_2 \xrightarrow{\Delta} \text{Ni(s)}$
 b) impure Ni + CO $\xrightarrow{50^{\circ}\text{C}} \text{Ni(CO)}_4(\text{g}) \xrightarrow{\Delta} \text{Ni(s)} + \text{CO(g)} \xrightarrow{\text{Condensation}} \text{Ni(s) pure}$
 c) impure Ni + $\text{CO}_2 \xrightarrow{50^{\circ}\text{C}} \text{Ni(CO)}_4(\text{s}) \xrightarrow{\Delta} \text{Ni(s)} + \text{CO(g)}$
 d) impure Ni + $\text{CO}_2 \xrightarrow{50^{\circ}\text{C}} \text{Ni(CO)}_4(\text{g}) \xrightarrow{230^{\circ}\text{C}} \text{Ni(s)} + \text{CO(g)}$

16. In the purification Zr and Ti, which of the following is/are true ?

- a) $\text{Zr} + 2\text{I}_2 \rightarrow \text{ZrI}_4(\text{g}) \xrightarrow[\text{the white hot W}]{\text{passed over}} \text{the pure Zr is deposited on W :}$
 b) $\text{Ti} + 2\text{I}_2 \rightarrow \text{TiI}_4(\text{g}) \xrightarrow[\text{the white hot W}]{\text{passed over}} \text{the pure Ti is deposited on W}$
 c) $\text{Zr} + 2\text{I}_2 \rightarrow \text{ZrI}_4(\text{s}) \xrightarrow[\& \text{then heated}]{\text{mixed with W}} \text{ZrI}_4 \text{ is reduced to ZrI}_2$
 d) Both a & b are correct

Matrix Matching Type Questions

17. **Column-I**

- A) Liquation
 B) Poling
 C) Cupellation
 D) Distillation

Column-II

- p) Volatile metals with non volatile impurity
 q) Metal with its metal oxides as impurity
 r) Metal with easily oxidisable impurities
 s) Metal and impurities differ in M.P.

18. **Column-I**

(Concentration method)

- A) Hydraulic washing
 B) Magnetic separation
 C) Froth flotation
 D) Leaching

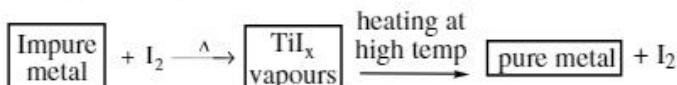
Column-II

(Principle)

- p) Difference in solubility of ore particles in a specific substance
 solubility of gangue
 q) Difference in wetting property of ore and gangue particles
 r) Difference in gravities of ore and gangue particles
 s) Difference in magnetic property of gangue and ore particles

Integer Type Questions

19. Ti is purified by following method:



Find the value of 'x'

20. How many alkaline earth metals is/are present in Dolomite?

EXERCISE-II

(Iron, copper, zinc, Tin lead)

LEVEL-I (MAIN)

Straight Objective Type Questions

- Which of the following is not formed during partial roasting of CuFeS_2 ?
 - Cu_2S
 - FeO
 - SO_2
 - CuSO_4
- Which is better oxidising agent for the reduction of ZnO ?
 - C
 - CO
 - CO_2
 - It is not possible to extract Zn by carbon reduction
- Which of the following pairs of reactions is not related to autoreduction process ?
 - $2\text{HgS} + 3\text{O}_2 \longrightarrow 2\text{HgO} + 2\text{SO}_2$; $2\text{HgS} + 3\text{O}_2 \longrightarrow 2\text{HgO} + 2\text{SO}_2$
 - $2\text{Cu}_2\text{S} + 3\text{O}_2 \longrightarrow 2\text{Cu}_2\text{O} + 2\text{SO}_2$; $2\text{Cu}_2\text{O} + \text{Cu}_2\text{S} \longrightarrow 6\text{Cu} + \text{SO}_2$
 - $2\text{Cu}_2\text{O} + \text{Cu}_2\text{S} \longrightarrow 6\text{Cu} + \text{SO}_2$; $2\text{PbO} + 2\text{C} \longrightarrow 2\text{Pb} + \text{CO}_2$
 - $\text{PbS} + \frac{3}{2}\text{O}_2 \longrightarrow \text{PbO} + \text{SO}_2$; $2\text{PbO} + \text{PbS} \longrightarrow 3\text{Pb} + \text{SO}_2 \uparrow$
- Which of the following reactions is related to Bessemerisation of Matte in Bessemer converter in the presence of air?
 - $2\text{FeS} + 3\text{O}_2 \longrightarrow 2\text{FeO} + 2\text{SO}_2$
 - $\text{FeO} + \text{SiO}_2 \longrightarrow \text{FeSiO}_3$
 - $2\text{Cu}_2\text{S} + 3\text{O}_2 \longrightarrow 2\text{Cu}_2\text{O} + 2\text{SO}_2$
 - All of the above
- Which of the following type of iron can be welded easily?
 - Cast iron
 - Wrought iron
 - Steel
 - All of these
- Select CORRECT matching.

1) Pyrometallurgy : Extraction of Fe	2) Electrometallurgy : Extraction of Al
3) Hydrometallurgy : Extraction of Au	4) All of the above are correct
- Magnatite is better written as :

III	II	III II	II III
1) Fe_2O_3	2) FeO	3) FeFe_2O_4	4) FeFe_2O_4
- "Blister copper" is :
 - mixture of $\text{Cu}_2\text{S} + \text{Cu}_2\text{O}$
 - Cu_2S with some FeS
 - Cu_2S with some FeO
 - metallic copper with 1-2% impurity

Numerical Value Type Questions

15. The formula of Gibsite is $\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ there 'x' is
 16. The no.of faradays of electricity required for the deposition of 0.9g of Allunimum is 10^{-x} F 'x' is

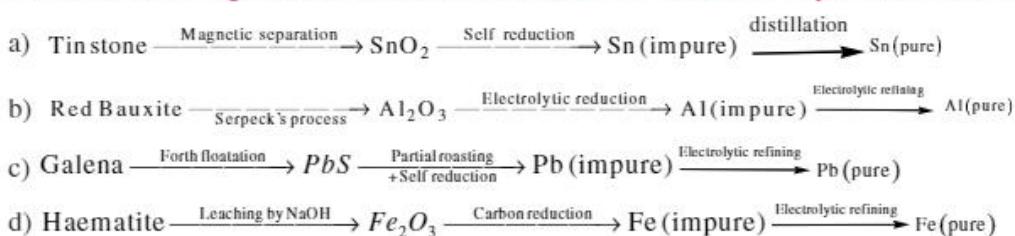
LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. Upon heating with Cu_2S the reagent(s) that give copper metal is/are :
a) CuFeS_2 b) CuO c) Cu_2O d) CuSO_4

2. In which of the following metal extraction following steps are involved
i) Roasting ii) Carbon reduction iii) Electrolytic refining
a) Zn from ZnS b) Pb from PbS c) Fe from Fe_2O_3 d) Mg from MgCl_2

3. Select the flow diagram(s) which is/are CORRECT for extraction of particular metal from its ore.



4. Step(s) which is/are involved in the extraction of Cu from its low grade ore :
- leaching by acid/bacteria
 - leaching by NaCN
 - metal displaced by scrap iron
 - metal displaced by Ag

More than One correct answer Type Questions

5. Both copper carbonate and copper hydroxide are present in :
- malachite
 - azurite
 - chalcopyrite
 - verdigris
6. The carbon based reduction method is not used for the extraction of :
- tin from SnO_2
 - iron from Fe_2O_3
 - aluminium from Al_2O_3
 - magnesium from $\text{MgCO}_3\text{CaCO}_3$
7. Which processes is/are used to oxidise impurity present in crude metal which is obtained by reduction of ore?
- Poling of bilster Cu
 - Steel manufacturing from pig iron
 - Cupellation of Ag
 - Electrolytic refining of Ag (with impurity Au)
8. Copper is purified by electrolytic refining of blister copper. The CORRECT statement(s) about this process is (are) :
- impure Cu strip is used as cathode
 - acidified aqueous CuSO_4 is used as electrolyte
 - pure Cu deposits at cathode
 - impurities settle as anode-mud

Linked Comprehension Type Questions

Passages :

The common ores of iron are both iron oxides and these can be reduced to iron by heating them with carbon in the form of coke. Coke is produced by heating coal in the absence of air. Coke is cheap and provides both the reducing agent for the reaction and also the heat source. The most commonly used iron ores are haematite, Fe_2O_3 and magnetite, Fe_3O_4

9. The reaction(s) which is/are primarily occur in the reduction zone in the extraction of iron haematite ore :
- $\text{Fe}_3\text{O}_4 + \text{CO} \rightarrow \text{CO}_2 + \text{Fe}_2\text{O}_3$
 - $\text{FeO} + \text{CO} \rightarrow \text{Fe} + \text{CO}_2$
 - $\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Fe} + 3\text{CO}$
 - $\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$
10. x,y,z and G in the following proceses are :
- $\text{P}_2\text{O}_5 + \dots \text{x} \xrightarrow{\Delta} \text{Thomas slage}$
 - $2\text{Cu}_2\text{O} + \text{Cu}_2\text{S} \xrightarrow{\Delta} \dots \text{y} \dots + \text{Gas(G)} \uparrow$
 - $\text{Fe}_2\text{O}_3 + 3\text{CO} \xrightarrow{\Delta} \dots \text{z} \dots + \text{Gas} \uparrow$
- Select which is incorrect :
- x = quick lime
 - y=matte
 - z = metallic iron
 - G=sulphur dioxide

Matrix Matching Type Questions

- | | |
|---------------------------------|--------------------------|
| 11. Column-I | Column-II |
| A) chalcopyrite → copper (pure) | p) froth floatation |
| B) zinc blend → zinc (pure) | q) carbon reduction |
| C) Bauxite → aluminium (pure) | r) roasting |
| D) galena → Lead (pure) | s) Au |
| | t) electrolytic refining |

12. Column-I

- A) Froth flotation
B) Self reduction
C) Roasting
D) Pyrometallurgy

Column-II

- p) Pb ore
q) Cu ore
r) Fe ore
s) Sn ore
t) Zn ore

Integer Type Questions

13. What is the oxidation state of Fe in fools gold

14. Number of water molecules in Mohr's salt

EXERCISE-III

(Sodium, magnesium, Aluminium, Silver and Gold)

LEVEL-I (MAIN)

Straight Objective Type Questions

- Hydrometallurgy is useful in the extraction of
1) Sn 2) Al 3) Hg 4) Ag
- Complex formation or cyanide method is used for the extraction of
1) Cu 2) Fe 3) Hg 4) Ag
- In the cyanide extraction process of silver from argentite ore, the oxidising and reducing agents used as
1) O₂ and CO respectively 2) O₂ and Zn dust respectively
3) HNO₃ and Zn dust respectively 4) HNO₃ and CO respectively
- Powdered silver ore is treated with NaCN solution and air is bubbled through the mixture to give
1) AgCN 2) Ag 3) Ag(CN)₂ 4) Na[Ag(CN)₂]
- 'Ag' obtained from argentoferous lead is purified by
1) Distillation 2) Flotation 3) Cupellation 4) Reaction with KCN
- In the extraction of lead from its ore galena an important element recovered is
1) Au 2) Ag 3) Cr 4) C
- Which of the following reagent is used to separate the impurity from red bauxite
1) Conc. HCl 2) Conc. H₂SO₄ 3) NaOH 4) HNO₃
- A mixture of Al₂O₃ and Fe₂O₃ can be separated by using
1) Sodium hydroxide 2) Cold water 3) Ethyl alcohol 4) Boiling water
- Match the following

A) Felspar	I) [Ag ₃ SbS ₃]
B) Asbestos	II) Al ₂ O ₃ . H ₂ O
C) Pyrargyrite	III) MgSO ₄ . H ₂ O
D) Diaspore	IV) K AlSiO ₃ O ₈
	V) Ca Mg ₃ (SiO ₃) ₄

The correct answer is

- | | | | |
|-------|---|-----|----|
| A | B | C | D |
| 1) IV | V | II | I |
| 3) IV | I | III | II |

- | | | | |
|-------|---|----|----|
| A | B | C | D |
| 2) IV | V | I | II |
| 4) II | V | IV | I |

10. Roasted gold ore + $\text{CN}^- + \text{H}_2\text{O} \xrightarrow{\text{O}_2} \text{lxl} + \text{OH}^-$, $\text{lxl} + \text{Zn} \longrightarrow \text{lyl} + \text{Au}$. lxl and lyl are
 1) $\text{x} = [\text{Au}(\text{CN})_2]^-$ $\text{y} = [\text{Zn}(\text{CN})_4]^{2-}$
 2) $\text{x} = [\text{Au}(\text{CN})_4]^{3-}$ $\text{y} = [\text{Zn}(\text{CN})_4]^{2-}$
 3) $\text{x} = [\text{Au}(\text{CN})_2]^-$ $\text{y} = [\text{Zn}(\text{CN})_6]^{4-}$
 4) $\text{x} = [\text{Au}(\text{CN})_4]^{3-}$ $\text{y} = [\text{Zn}(\text{CN})_6]^{4-}$

Numerical Value Type Questions

11. How many of the following are oxide ores. Calamine, Cuprite, Zincite, Chalcocite, Haematite, Bauxite, Magnetite, Caesiterite
 12. How many metals are commercially extracted by hydro metallurgy from the given metals Ag, Mn, In, Cr, Pb, Au

LEVEL-II (ADVANCED)**Straight Objective Type Questions**

1. Electrolytic reduction of alumina to aluminium by Hall - Heroult process is carried out
 - a) in the presence of NaCl
 - b) in the presence of fluorite
 - c) in the presence of cryolite which forms a melt with lower melting temperature
 - d) in the presence of cryolite which forms a melt with higher melting temperature
2. The ideal of froth floatation method came from a person X and this method is related to the process Y of ores. X and Y, respectively, are:
 - a) washer man and reduction
 - b) Fisher women and concentration
 - c) washer women and concentration
 - d) Fisher man and reduction
3. Leaching is a process of
 - a) Separation of ore from gangue by making it soluble with the addition of a chemical reagent where gangue is insoluble
 - b) Separation of ore from gangue making the gangue soluble with the addition of a chemical reagent where ore is insoluble
 - c) Separation of ore from gangue with an upward stream of running water where the lighter ore come along with water
 - d) Separation of the ore by melting it on an inclined hearth where as gangue having high melting point left behind
4. In Bayer's process before digesting the ore with concentrated Sodium hydroxide it must be
 - a) Dissolved in cryolite
 - b) Roasted to convert FeO to Fe_2O_3
 - c) Evaporated to remove water
 - d) Dissolved in CaF_2

More than One correct answer Type Questions

5. Which out of the following metals can be obtained by electrolysis of the aqueous solution of their salts ?
 - a) Ag
 - b) Mg
 - c) Au
 - d) Na
6. Silver containing lead as an impurity is not purified by
 - a) Poling
 - b) Cupellation
 - c) Levigation
 - d) Distillation
7. Which of the following minerals/ores contain(s) magnesium ?
 - a) Magnetite
 - b) Magnesite
 - c) Asbestos
 - d) Carnalite

8. The function of adding cryolite in the electrolytic reduction of alumina by Hall-Heroult process is to:

 - a) dissolve alumina
 - b) lower the melting point of alumina
 - c) Lower the fuel boiling point
 - d) increase the electrical conductivity of alumina

9. Highly electropositive metals can not be extracted by carbon reduction process because these :

 - a) Metals combine with carbon to form carbides
 - b) Metal oxides are reduced by carbon
 - c) Metal oxides are not reduced by carbon
 - d) Loss of metal is more by vapourisation

10. The function of adding cryolite in the electrolytic reduction of alumina by Hall-Heroult process is to

 - a) Dissolve alumina
 - b) Lower the melting point of alumina
 - c) Lower the fuel boiling point
 - d) Increase the electrical conductivity of alumina

11. Which is (are) ore(s) of aluminium

 - a) Cryolite
 - b) Bauxite
 - c) Malachite
 - d) Cuprite

12. Which of the following minerals/ores contain(s) magnesium

 - a) Magnetite
 - b) Magnesite
 - c) Asbestos
 - d) Carnalite

13. Which of the following statements regarding the metallurgy of magnesium using electrolytic method is not correct

 - a) Electrolyte is magnesium chloride containing a little of NaCl and NaF
 - b) Air tight iron pot acts as a cathode
 - c) Electrolysis is not done in the atmosphere of coal gas
 - d) Molten magnesium is heavier than the electrolyte

Linked Comprehension Type Questions

Passage - I :

Magnesium is a valuable, light weight metal used as a structural material as well as in alloys, batteries and in chemical synthesis. Although magnesium is plentiful in earth's crust, it is mainly found in the sea water after sodium. There is about 1.3g of magnesium in every kilogram of sea water. The process for obtaining magnesium from sea water employs all three types of reactions, ie..... precipitation acid-base and redox reactions.

14. Acid-base reaction involves reaction between
a) MgCO_3 and HCl b) Mg(OH)_2 and H_2SO_4 c) Mg(OH)_2 and HCl d) MgCO_3 and H_2SO_4

15. Redox reaction takes place (in the extraction of Mg)
a) In the electrolytic cell when fused MgCl_2 is subjected to electrolysis
b) When fused MgCO_3 is heated
c) When fused MgCO_3 is strongly heated d) None of the above

16. Electron is an alloy of
a) Magnesium b) Sodium c) Aluminium d) Manganese

Passage - II :

Much of the world supply of platinum group metal i.e., derived from the residues recovered from the electrolytic refining of copper and nickyl. The residues when heated with aqua regia the gold, pt and pd go in to solution. This is filtered off and to the filtrate on adding Ferrous sulphate solution gold is precipitated the platinum and palladium remain in solution

17. The solubility of the gold, platinum and palladium in aqua regia is due to the formation of
 a) AuCl_2 , PtCl_2 , PdCl_2
 b) AuCl_3 , PtCl_4 , PdCl_4
 c) HAuCl_4 , H_2PtCl_6 , H_2PdCl_4
 d) HAuCl_4 , H_2PtCl_4 , H_2PdCl_4
18. The role of Ferrous sulphate in the incipitation of gold is
 a) Oxidation
 b) Reductant
 c) Complex agent
 d) Substituent
19. The structures of compounds of Pt and Pd remained in the solution are
 a) Square planar and square planar
 b) Square planar and Tetrahedral
 c) Tetrahedral and Square planar
 d) Octahedral and Square planar

Passage - III :

Silver metal is extracted from Ag_2S by cyanide process. The ore is concentrated through froth floatation process. The concentrated ore is then leached and solution is treated with reducing agents to get spongy silver which is then purified by fusion with an oxidant followed by electrolysis

20. Leaching of Ag_2S is carried out by heating it with a dilute solution of
 a) NaCN alone
 b) NaCN in presence of O_2
 c) HCl
 d) NaOH
21. Ag is precipitated from an aqueous solution of sodium argentocyanide by adding
 a) Zn dust
 b) Cu power
 c) NaHg
 d) $\text{Na}_2\text{S}_2\text{O}_3$
22. Which of the following statements about electrolytic refining of silver is not true
 a) Anode consists of impure silver
 b) cathode consists of pure silver
 c) Electrolytic solution consists of AgNO_3 and HNO_3
 d) Elecipitated solution consists of AgNO_3 and HCl

Matrix Matching Type Questions

- | | |
|--|--|
| 23. Column-I
A) Argentite
B) Horn silver
C) Ruby silver
D) Sylvine | Column-II
p) KCl
q) AgCl
r) Ag_2S
s) $3\text{Ag}_2\text{S} \cdot \text{Sb}_2\text{S}_3$ |
| 24. Column-I
A) Cyanide process
B) Floatation proces
C) Electrolytic reduction
D) Zone refining | Column-II
p) Ultrapure Ge
q) Pine oil
r) Extraction of Al
s) Extraction of Au |

Integer Type Questions

25. How many cyanide ions are involved in the following chemical equation



KEY SHEET (PRACTICE SHEET)

EXERCISE-I

LEVEL-I

1) 1 2) 2 3) 1 4) 3 5) 2 6) 6

LEVEL-II

1) c 2) b 3) c 4) c 5) a 6) b 7) c 8) ab
 9) abcd 10) ab 11) c 12) a 13) a 14) a 15) b 16) d
 17) A-s; B-q; C-r; D-p 18) A-r; B-s; C-q; D-p 19) 4 20) 2

EXERCISE-II

LEVEL-I

1) 4 2) 1 3) 3 4) 4 5) 2 6) 4 7) 4 8) 4
 9) 4 10) 4 11) 1 12) 1 13) 1 14) 4 15) 3
 16) 1

LEVEL-II

1) c 2) a 3) c 4) a 5) ab 6) cd 7) bc 8) bcd
 9) b 10) b 11) A-prst; B-pqrt; C-t; D-pqst
 12) A-pqt; B-pq; C-pqrst; D-pqrst 13) 2 14) 6

EXERCISE-III

LEVEL-I

1) 4 2) 4 3) 2 4) 4 5) 3 6) 2 7) 3 8) 1
 9) 2 10) 1 11) 6 12) 2

LEVEL-II

1) c 2) c 3) a 4) b 5) ac 6) ac 7) bcd 8) acd
 9) ad 10) abcd 11) ab 12) bcd 13) cd 14) c 15) a 16) a
 17) c 18) b 19) d 20) b 21) a 22) c
 23) A-r; B-q; C-s; D-p 24) A-s; B-q; C-r; D-p 25) 8

ADDITIONAL PRACTICE EXERCISE

LEVEL-I (MAIN)

Straight Objective Type Questions

- Identify x , y , z for the following metallurgical process. Metal sulphide \xrightarrow{x} Metal \xrightarrow{y} Impure metal \xrightarrow{z} Pure metal.
 - Roasting, reduction, electrolysis
 - Roasting, calcination, smelting
 - Roasting, auto-reduction, Bessemerization
 - None of the above is correct
- One of the processes used for concentration of ores is froth floatation process. This process is generally used for concentration of sulphide ores. Sometimes in this process we add NaCN as a depressant in case of ZnS and PbS minerals. What is the purpose of addition of NaCN during the process of froth floatation ?
 - NaCN causes reduction by precipitation
 - A soluble complex is formed by reaction between NaCN and ZnS while PbS forms froth
 - A soluble complex is formed by reaction between NaCN and PbS while ZnS forms froth
 - A precipitate of $Pb(CN)_2$ is produced while ZnS remain unaffected.

3. Zinc is extracted from ZnS by the
- Calcination of ZnS followed by hydrogen reduction at 400°C
 - Calcination of ZnS followed by carbon monoxide reduction
 - Roasting of ZnS followed by aluminium reduction at 1200°C in a muffle furnace
 - Roasting of ZnS followed by carbon reduction at 1200°C in a smelter
4. Consider the following steps $\text{Cu}_2\text{S} \xrightarrow{\text{roast in air}} \text{A} \xrightarrow{\text{roast without air}} \text{B}$. What is not the correct statement ?
- It is self reduction
 - It involves disproportionate ion $\text{Cu}_2\text{S} \rightarrow \text{Cu} + \text{CuS}$
 - Is a mixture of Cu₂O and Cu₂S and B is a mixture of Cu and SO₂.
 - Conversion of A to B take place in Bessemerization
5. Consider the following metallurgical processes.
- Heating metal with CO and distilling the resulting volatile carbonyl (b.p. 43°C) and finally decomposing at 150°C to 200°C to get the pure metal.
 - Heating the sulphide ore in air until a part is converted to oxide and then further heating in the absence of air to let the oxide react with unchanged sulphide.
 - Electrolyzing the molten electrolyte containing approximately equal amounts of the metal chloride and CaCl₂ to obtain the metal.
- The process used for obtaining sodium, nickel and copper are respectively.
- a, b and c
 - b, c and a
 - c, a and b
 - b, a and c
6. Which is not the correct statement
- Cassiterite, chromites and pitch blende are concentrated by hydraulic washing
 - Pure Al₂O₃ is obtained from the bauxite ore by leaching in the Baeyer's process
 - Sulphide ore is concentrated by calcination method
 - Roasting can convert sulphide into oxide or sulphate and part of sulphide may also act as a reducing agent.
7. Froth floatation process used for the concentration of sulphide ore :
- Is based on the difference in wettability of different minerals.
 - Uses sodium ethyl xanthate, C₂H₅OCS₂Na as collector.
 - Uses NaCN as depresent in the mixture of ZnS and PbS when ZnS forms soluble complex and PbS forms froth
 - All are correct statements
8. In the leaching of Ag₂S with NaCN, a stream of air is also passed. It is because of
- reversible nature of reaction between Ag₂S and NaCN is prevented
 - to oxidize Na₂S formed into Na₂SO₄
 - Both (1) and (2)
 - None of the above
9. In the extraction of aluminium

Process (X) : Applied for red bauxite to remove iron oxide (chief impurity)

Process (Y) : (Serpeck's process) : applied for white bauxite to remove 'Z' (chief impurity) then, process X and impurity Z are :

- X - Hall and Heroult's process and Z - SiO₂
- X - Baeyer's process and Z - SiO₂
- X - Serpeck's process and Z - iron oxide
- X - Baeyer's process and Z - iron oxide

10. Bilster copper is refined by stirring molten impure metal with green logs of wood because such as a wood liberates hydrocarbon gases (like CH_4). This process X is called and the metal contains impurities of 'Y' is
- 1) X - Cupellation, Y = Cu_2O
 - 2) X = Polling, Y = Cu_2O
 - 3) X = Polling, Y = CuO
 - 4) X = Cupellation, Y = CuO
11. In zone refining method, the molten zone
- 1) Consists of impurities only
 - 2) Contain impurity than the original metal
 - 3) Contains the purified metal
 - 4) Moves to either side
12. Formation of metallic copper from the sulphide ore in the commercial thermo-metallurgical process essentially involves which one of the following reaction.
- 1) $\text{Cu}_2\text{S} + \frac{3}{2}\text{O}_2 \rightarrow \text{Cu}_2\text{O} + \text{SO}_2$; $\text{CuO} + \text{C} \rightarrow \text{Cu} + \text{CO}$
 - 2) $\text{Cu}_2\text{S} + \frac{3}{2}\text{O}_2 \rightarrow \text{Cu}_2\text{O} + \text{SO}_2$; $2\text{Cu}_2\text{O} + \text{Cu}_2\text{S} \rightarrow 6\text{Cu} + \text{SO}_2$
 - 3) $\text{Cu}_2\text{S} + 2\text{O}_2 \rightarrow \text{CuSO}_4$; $\text{CuSO}_4 + \text{Cu}_2\text{S} \rightarrow 3\text{Cu} + 2\text{SO}_2$
 - 4) $\text{Cu}_2\text{S} + \frac{3}{2}\text{O}_2 \rightarrow \text{Cu}_2\text{O} + \text{SO}_2$; $\text{Cu}_2\text{O} + \text{CO} \rightarrow 2\text{Cu} + \text{CO}_2$
13. Froth floatation process for concentration of ores is an illustration of the practical application of
- 1) Adsorption
 - 2) Absorption
 - 3) Coagulation
 - 4) Sedimentation
14. In a mixture of PbS , ZnS and FeS each component is separated from other by using the reagents in the sequence in froth floatation process.
- 1) Potassium ethyl xanthate, KCN
 - 2) Potassium ethyl xanthate, KCN , NaOH , CuSO_4 acid
 - 3) KCN , CuSO_4 , acid
 - 4) None of these
15. Which of the following reaction is involved in the extraction of Cu by Bessemer process ?
- 1) $\text{Cu}_2\text{S} + 2\text{Cu}_2\text{O} \rightarrow 6\text{Cu} + \text{SO}_2$
 - 2) $\text{Cu}_2\text{S} + \text{O}_2 \rightarrow 2\text{Cu} + \text{SO}_2$
 - 3) $\text{Cu}_2\text{O} + \text{C} \rightarrow 2\text{Cu} + \text{CO}$
 - 4) $\text{Cu}_2\text{O} + \text{Zn} \rightarrow \text{ZnO} + 2\text{Cu}$
16. Which of the following reaction sequences is correct for the extraction of gold ?
- 1) $\text{AuCN} + \text{Na}_2\text{SO}_4 \rightarrow \text{A} \xrightarrow{\text{Zn}} \text{Gold}$
 - 2) $\text{Au} + \text{NaCN} + \text{H}_2\text{O} + \text{O}_2 \rightarrow \text{A} \xrightarrow{\text{Zn}} \text{Gold}$
 - 3) $\text{Au}_2\text{S}_3 + \text{NaCN} + \text{H}_2\text{O} + \text{O}_2 \rightarrow \text{A} \xrightarrow{\text{Mg}} \text{Gold}$
 - 4) $\text{Au} + \text{NaCN} + \text{H}_2\text{O} + \text{O}_2 \rightarrow \text{A} \xrightarrow{\text{Zn}(\text{CN})_4^{2-}} \text{Gold}$
17. Silica is added to roasted copper ore during extraction in order to remove.
- 1) Cuprous sulphide
 - 2) Ferrous oxide
 - 3) Ferrous sulphide
 - 4) Cuprous oxide

18. Match List-I with List-II

List-I (Property)	List-II (Element/Compound)
I) Explosive	A : Cu
II) Self-reduction	B : Fe ₃ O ₄
III) Magnetic material	C : Cu(CH ₃ COO) ₂ ·Cu(OH) ₂
IV) Verdigris	D : Pb(NO ₃) ₂
1) I-A, II-B, III-C, IV-D	2) I-D, II-A, III-B, IV-C
3) I-D, II-B, III-A, IV-C	4) I-C, II-A, III-B, IV-D

19. The method of cupellation is used to separate silver from

- 1) iron 2) lead 3) cobalt 4) zinc

20. Which of these industrial processes does not involve oxidation or reduction ?

- 1) Formation of iron from the reaction of iron ore and carbon monoxide
 2) Electrolysis of molten aluminium ore
 3) Purification of zinc ore by roasting with pure oxygen
 4) The addition of NaOH to digest aluminium oxides

21. Which of the following statement is correct ?

- 1) Pig iron or cast iron is hard and brittle
 2) The type of iron that contains maximum amount of iron is pig iron.
 3) The type of iron that contains maximum amount of carbon is wrought iron
 4) The hardness of steel increases as its carbon content decreases

22. Which process of purification is represented by the following equation ?



- 1) Cupellation 2) Polling 3) Van Arkel process 4) Zone refining

23. If the temperature needed for carbon to reduce an oxide is too high for economic practical purpose, then reduction can be affected by using another highly electropositive element which is

- 1) Al 2) Mg 3) Na 4) All of these

24. Which of the following is true for wrought iron ?

- 1) It is extremely tough, highly malleable and ductile 2) It softens about 1000°C
 3) It has a fibrous structure 4) It is resistant towards rusting

Numerical Value Type Questions

25. 'p' Au + qCN⁻ + H₂O + O₂ → X + OH⁻. In the balanced stoichiometric equation the 'q' value is
26. Given Sn, Cu, Ni, Zr, Ti, Ag, Au, Hf, The no. of metals purified by polling is 'x' and no. of metals purified by vapour phase thermal decomposition is 'y' x + y is _____
27. Among the metals. Ti, V, W, Zr, Th and Au, the number of metals purified by van Arkel method are
28. Zn – Ag alloy containing Pb is subjected to liquification (a refining process), then one of the metal is removed as impurity, the group number of that metal is _____ [roman number].

LEVEL-II

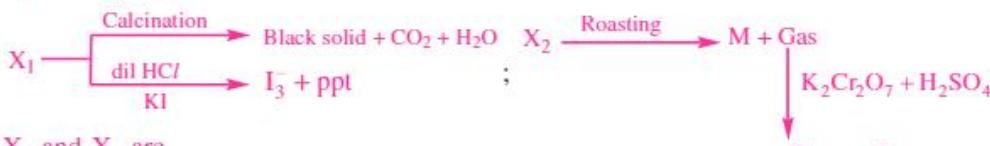
LECTURE SHEET (ADVANCED)

Straight Objective Type Questions

1. Four statements are given below identify the CORRECT statement.

- a) In Gould schmidt thermite process aluminium acts as reducing agent
- b) Mg is extracted by electrolysis of aqueous $MgCl_2$ solution
- c) Aluminium can be extracted by carbon reduction method
- d) Red bauxite is purified by Serpeck's process

2. X_1 and X_2 are the ores of a metal M



X_1 and X_2 are

- a) Malachite and chalcocite
- b) Zinc blende and calamine
- c) Galena and anglesite
- d) Argentite and horn silver

3. Consider the following statements.

- i) Copper is extracted by hydrometallurgy from high grade ore
- ii) $2Cl^- (aq) + 2H_2O(l) \rightarrow 2OH^- (aq) + H_2(g) + Cl_2(g)$ $\Delta G^\circ = -422\text{ kJ}$
- iii) Impurities from the blister copper deposit as anode mud which contains Sb, Se, Te, Ag, Au and Pt
- iv) Nickel steel is used for marking cables, automobiles and aeroplane parts, pendulum, measuring tapes. Which of the above statements are correct.

- a) i, ii, iii, iv
- b) ii and i
- c) iii and iv
- d) i and iii

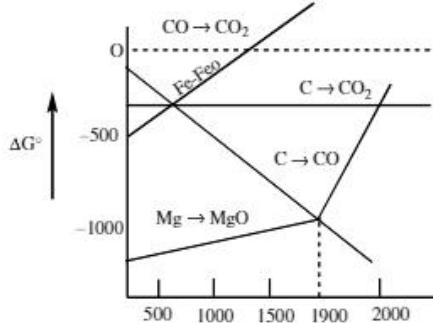
4. During the process of electro refining of copper, which of the following options is WRONG.

- a) Some metals (Ag and Au) present as impurity settle as anode mud
- b) Dil $CuSO_4$ is used as an electrolyte
- c) Concentration of dil $CuSO_4$ should remain same during the process
- d) The impurity of Cu_2O is removed

5. The set of metals whose extraction involves hydrometallurgy is

- a) Na, Zn, Al
- b) Au, Fe, Cu
- c) Cu, Ag, Au
- d) Hg, Ag, Au

6. Using the Ellingham diagram shows the temperature at which MgO can be reduced to metal by carbon. It is



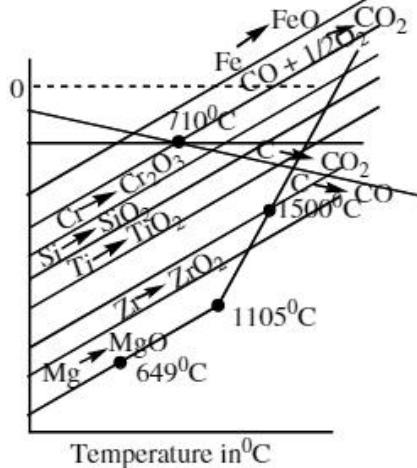
- a) Below 1500°C
- b) Below 1120°C
- c) Above 1900°C
- d) Below 1600°C

More than One correct answer Type Questions

7. Magnetic separation is used for refining the ore
 a) Magnesite b) haematite c) cassiterite d) Azurite
8. The impure metal obtained is further purified using poling/ liquation/zone refining or electrolysis.
 Poling is used in the purification of
 a) Pb b) Cu c) Sn d) Iron
9. Which of the following are the oxide ores ?
 a) Haemetite b) Limonite c) Cryolite d) Pitch blende
10. Which metals can be extracted commercially by using coke ?
 a) Fe b) Zn c) Al d) Sn
11. Zone refining is used to purify
 a) Germanium b) Gallium c) Silicon d) Copper

*Linked Comprehension Type Questions**Passage*

The Ellingham diagram represents the formation of oxides of several metals together with oxides of carbon



12. In the carbon reduction of iron oxides is carried out below 710°C , the chief reducing agent is
 a) C b) CO
 c) both C and CO d) not possible to predict
13. which of the following statements is wrong ?
 a) Al can reduce Cr_2O_3 as well as TiO_2
 b) Al cannot reduce ZrO_2 but Mg can reduce ZrO_2
 c) Al can reduce MgO at above 1500°C
 d) Si cannot reduce MgO

Matrix Matching Type Questions

14. **Column-I**
(Metallurgical process)

- A) Distillation
- B) Van Arkel method
- C) Liquation
- D) Electrolysis

- Column-II**
(Metal refined)

- p) zinc
- q) zirconium
- r) copper
- s) Tin

15. **Column I**

- A) Bauxite
- B) Carnalite
- C) Copper pyrites
- D) Haematite

- Column II**

- p) Self reduction
- q) Roasting
- r) Electrolytic reduction
- s) Calcination

Integer Type Questions

16. The number of silver containing compounds among following are Nessler's reagent, Tollen's reagent, Baeyers reagent, corrosive sublimate, horn silver, Ruby silver, colemel, lunar caustic, Silvine.
17. Carbon based reduction method is not used for the extraction of metals from which of the following
- | | | | | |
|--------------------|----------------------------|----------------------------|----------------------------|--------------------|
| 1) SnO_2 | 2) Fe_2O_3 | 3) ZnO | 4) Al_2O_3 | 5) MgCO_3 |
| 6) CaCO_3 | 7) NiO | 8) Cr_2O_3 | 9) PbO | |
18. In a given sample of bleaching powder the percentage of chlorine is 49. The volume in litre of chlorine obtained if 40 g of the sample is treated with CO_2 at STP is

PRACTICE SHEET (ADVANCED)*Straight Objective Type Questions*

1. Extraction of zinc from zinc blende is achieved by
 - a) Electrolytic reduction
 - b) Roasting followed by reduction with carbon
 - c) Roasting followed by reduction with another metal
 - d) Roasting followed by self reduction
2. In the reverbaratory furnace copper is produced in the form of copper matte, which contains
 - a) FeO , Cu_2S
 - b) Cu_2S , Fe_2O_3
 - c) Cu_2O , FeS
 - d) Cu_2S , FeS
3. By which process Pb and Sn are extracted respectively
 - a) Carbon reduction - self reduction
 - b) Self reduction - carbon reduction
 - c) Electrolytic reduction - cyanide process
 - d) Cyanide process - Electrolytic reduction
4. during the process of electro refining of copper some metals present as impurity settle as anode mud. These are
 - a) Sn and Ag
 - b) Pb and Cu
 - c) Ag and Au
 - d) Fe and Ni
5. The slag formed during the Bessemer process in the extraction of copper is
 - a) FeSiO_3
 - b) MgSiO_3
 - c) $\text{Ca}_3(\text{PO}_4)_2$
 - d) CaSiO_3

More than One correct answer Type Questions

The metal obtained this way is

- a) Gold
- b) Lead
- c) Silver
- d) Aluminum

7. Correct the statements of the following are

a) In auto reduction process of copper. The part of cuprousulphide is oxidized wih cuprous oxide to form a free copper metal. The balanced equation is as follows



b) Number of ligands in the stable volatile complex formed during the extraction of Ni by Mond's process is '4'

c) The percent impurity in 23 carat gold is nearly four

d) The metal which cannot be obtained by electrolysis of an aqueous solution of its salt in Cu

8. Among the following statements the correct statements is (are)

- a) Calamine, siderite, malachite are carbonate ores
- b) Celestite, Anglesite are sulphate ores
- c) Alumina can be purified by Baeyers process and Hall's process
- d) The alloy of zinc metal is Brass

9. The statement that are correct among the given are

- a) a furanace lined with haematite is used to convert cast iron to wrought iron
- b) Copper from low grade ores is extracted by hydrometallurgy
- c) Collectors enhance the wettability of mineral particles during froth floatation process
- d) in vapour phase refining metal should form a volatile compound

10. Correct statements of the following are

- a) Poling is the process is used for the removal of Cu_2O from Cu
- b) The process used for the refining of Al and Zn metals respectively are Hoopes process and cupellation
- c) Van Arkel method in use for the purification metals which are volatile and stable compounds
- d) The most electropositive metals are extracted from there ionic salts by the electrolysis in fused state

11. Based on the given information $\Delta G_f^0(\text{CaO}) = -604.2 \text{ Kj/mol}$ and $\Delta G_f^0(\text{Al}_2\text{O}_3) = -1582 \text{ Kj/mol}$ which of the following is correct

- a) $3\text{CaO} + 2\text{Al} \rightarrow \text{Al}_2\text{O}_3 + 3\text{Ca}$ is spontaneous
- b) $3\text{CaO} + 2\text{Al} \rightarrow \text{Al}_2\text{O}_3 + 3\text{Ca}$ is non spontaneous
- c) ΔG^0 for the reaction $3\text{CaO} + 2\text{Al} \rightarrow \text{Al}_2\text{O}_3 + 3\text{Ca}$ is $+230.6$
- d) ΔG^0 for the reaction $3\text{CaO} + 2\text{Al} \rightarrow \text{Al}_2\text{O}_3 + 3\text{Ca}$ is -977.8

12. In the extraction of iron from haematite in blast furnace reducing agent

- a) at low temperature CO is effective
- b) At low temperature CO_2 is effective
- c) At high temperature carbon is more effective
- d) Both carbon and CO are equally effective at high temperature

Matrix Matching Type Question

13. Match the metal given in column-I with the process related directly for the extraction of metal or for the extraction of other metal

Column - I

- A) Pb
- B) Ag
- C) Zn
- D) Au

Column - II

- p) Parkes process
- q) Pattinsons process
- r) Me Arthur Forrest cyanide process
- s) Electrorefining

Integer Type Questions

14. Hausamanite is Mn_xO_y 'p' $Mn_xO_y + 'q' Al$ (powder) $\xrightarrow{\Delta} Mn + Al_2O_3$. Give the correct composition of the hausmanite. Balance the equation. The value 'q' (minimum value) in the stoichiometric equation is
15. $xFe_2O_3 + y CO \rightarrow Fe + CO_2$. Balance the equation, the 'y' (minimum value) in the stoichiometric equation is
16. $FeS_2 + O_2 \rightarrow P + Q$. The oxidation state of iron in FeS_2 is 'x', the oxidation state of iron in 'P' is y. The oxidation state of sulphur in 'Q' is 'z'. Then $9x + y + z$ is
17. 'Matte' contains A + B, the oxidation state of the metals in A and B are 'x' and 'y'. ($x + y$) is.

KEY SHEET (ADDITIONAL PRACTICE EXERCISE)**LEVEL-I (MAIN)**

- | | | | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1) 1 | 2) 2 | 3) 4 | 4) 2 | 5) 3 | 6) 3 | 7) 4 | 8) 3 | 9) 2 | 10) 2 |
| 11) 2 | 12) 2 | 13) 1 | 14) 2 | 15) 1 | 16) 2 | 17) 2 | 18) 2 | 19) 2 | 20) 4 |
| 21) 1 | 22) 3 | 23) 4 | 24) 1 | 25) 8 | 26) 5 | 27) 3 | 28) 4 | | |

LEVEL-II**LECTURE SHEET (ADVANCED)**

- | | | | | | | | | | |
|---------|-------|-------|----------------------------|--------------------------------|------|-------|-------|--------|---------|
| 1) a | 2) a | 3) c | 4) d | 5) c | 6) c | 7) bc | 8) bc | 9) abd | 10) abd |
| 11) abc | 12) a | 13) d | 14) A-p; B-q; C-s; D-p,r,s | 15) A-r,s; B-r,s; C-p,q; D-q,s | | | | | |
| 16) 4 | 17) 3 | 18) 6 | | | | | | | |

PRACTICE SHEET (ADVANCED)

- | | | | | | | | | |
|--------|--------|--------|--|-------|-------|--------|---------|--------|
| 1) b | 2) d | 3) b | 4) c | 5) a | 6) ac | 7) abc | 8) abcd | 9) abd |
| 10) ad | 11) bc | 12) ac | 13) A-p,q,s; B-p,q,r,s; C-p,r,s; D-r,s | 14) 8 | 15) 3 | 16) 3 | | |
| 17) 3 | | | | | | | | |

