65. (c) Carnalite is an important ore of magnesium. It is $KCl.MgCl_2.6H_2O$

67. (c) Al is most abundant metal in the earth crust

68. (d) Chalcopyrite $(CuFeS_2)$

70. (a) Cassiterite - SnO_2

Cryolite - Na_3AlF_6

Cerussite - $PbCO_3$

71. (b) Carnalite is the ore of K and Mg its formula is $KCl.MgCl_2.6H_2O$

72. (b) Pyrolusite – MnO_2

Malachite – $CuCO_3.Cu(OH)_2$

Diaspore – $Al_2O_3.H_2O$

Cassiterite – SnO_2

Concentration

1. (a) Froth floatation method is based on the fact that the surface of sulphide ores is preferentially wetted by oil while that of gangue is wetted by water.

4. (c) Haematite (Fe_2O_3)

Iron ores are concentrated by this method

5. (b) Pine oil is foaming agent. Now another substance collector such as potassium ethyl xanthate or amyl xanthate are added.

6. (c) Cinnabar (HgS) the ore of mercury is concentrated by froth floatation process.

7. (c) Cyanide process is used in the extraction of both Silver and Gold because these form complex salts with CN^- ion due to presence of lone pair of electron on nitrogen atom.

8. (b) Cassiterite SnO_2 or tinstone – an ore of tin being non-magnetic can be separated from magnetic impurities like *Fe* and *Mn* from this method.

13. (c) Chemical separation or Leaching.

In this powdered ore is treated with a suitable reagent which can dissolve the ore but not the impurities.

14. (d) Copper pyrite $CuFeS_2$ (Chalcopyrite)

16. (c) Sulphides ores are always concentrated by froth floatation process

20. (a) Froth floatation because it is sulphide ore (ZnS)

22. (a) Here only Galena is PbS (a sulphide ore).

Cassiterite is SnO_2 (oxide ore). Magnetite is Fe_3O_4 (Oxide ore) and Malachite is $Cu(OH)_2.CuCO_3$ (Carbonate ore). The froath floatation process is used to concentrate sulphide ores, based on preferential wetting properties with froating agent and water.

Roasting & Calcination

1. (b) These are the substances which can withstand very high temperature without melting or becoming soft.

2. (a) To remove volatile substances.

$S_8 + 8O_2 \rightarrow 8\,SO_2 \uparrow$; $P_4 + 5O_2 \rightarrow P_4O_{10} \uparrow$

$4\,As + 3O_2 \rightarrow 2\,As_2O_3 \uparrow$

3. (c) In this process sulphides ores are converted into oxide ores $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2 \uparrow$

5. (c) $\underset{\text{Acidicflux}}{SiO_2}$ $\underset{\text{Basic flux}}{CaCO_3}$, lime, CaO

6. (a) (Impurity) $\underset{\text{Infusible}}{\text{Gangue}} + \text{flux} \rightarrow \underset{\text{Fusible}}{\text{Slag}}$

7. (a) $CaCO_3 \rightarrow CaO + CO_2$

Heating the ore in absence of air is calcination.

9. (b) Smelting is a process of reducing metal oxide to metal by means of coke or CO.

$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$

$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

13. (c) Flux is added during smelting it combines with infusible gangue present in the ore to form a fusible mass known as slag. $\text{Flux} + \text{Gangue} \rightarrow \text{Slag}$

15. (d) $CaO \rightarrow$ It is hygroscopic in nature

22. (b) Reduction with carbon is called smelting

$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$

25. (a) $\underset{\text{Impurity}}{SiO_2} + \underset{\text{Flux}}{CaO} \rightarrow \underset{\text{Slag}}{CaSiO_3}$

26. (c) Impurities of SiO_2 is present in the iron ore so basic flux $CaCO_3$ is added. $\underset{\text{Flux}}{CaO} + \underset{\text{Impurity}}{SiO_2} \rightarrow \underset{\text{Slag}}{CaSiO_3}$

28. (b) $CaCO_3 \rightarrow CaO + CO_2$; $\underset{\text{Flux}}{CaO} + \underset{\text{Impurityof haematite}}{SiO_2} \rightarrow \underset{\text{Slag}}{CaSiO_3}$

29. (b) $\underset{\text{Impurity}}{FeO} + \underset{\text{Flux}}{SiO_2} \rightarrow \underset{\text{Slag}}{FeSiO_2}$

30. (c) Hydrometallurgy

$Ag_2S + 4NaCN \rightarrow 2Na[Ag(CN)_2] + Na_2S$

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

31. (b) $Cu_2Cl_2 + Ag_2S \rightarrow Cu_2S + 2AgCl$

$2AgCl + Hg \rightarrow Hg_2Cl_2 + 2Ag$

$AgCl + Hg \rightarrow Ag + HgCl$

32. (d) Roasting (Sulphide ore is heated in excess of air)

33. (b) $ZnCO_3 \rightarrow ZnO + CO_2$

In calcination ore is heated in absence of air in a reverberatory furnace to remove moisture and CO_2

36. (b) $\underset{\text{Acidicimpurity}}{SiO_2} + \underset{\text{Basicflux}}{CaO} \rightarrow \underset{\text{Slag}}{CaSiO_3}$

39. (b) $\underset{1}{CaCO_3} + \underset{4}{\text{Coke}} + \underset{8}{\text{Calcined}}$

41. (b) Zinc blende (ZnS); $2ZnS + 3O_2 \xrightarrow{\Delta} 2ZnO + 2SO_2$

42. (c) When conc. HgS ore is roasted

$HgS + O_2 \xrightarrow{773-873\,K} Hg + SO_2$

At this temperature, mercury vaporises and the vapours are condensed to the liquid metal. Mercury so obtained is about 99.7% pure.

43. (d)

Combustion zone	1800 *K*
Fusion zone	1600 *K*
Slage zone	1300 *K*
Treduction zone	800 *K*

44. (b) In roasting process, the ore (usually sulphide) alone or mixed with other materials is heated in excess of air.

45. (d) Flux is used to fuse non-fusible impurities presents in ore.

46. (d) During extraction of Fe calcium silicate ($CaSiO_3$) slag is obtained.

47. (b) In Bessemer converter copper sulphide is partially oxidised to cuprous oxide which further reacts with remaining copper sulphide to form copper and sulphur dioxide. $Cu_2S + 2Cu_2O \rightarrow 6Cu + SO_2$

48. (d) Flux is used to remove silica and undesirable metal oxide.

49. (a) Roasting is the process of heating the ore strongly in the presence of excess of air. It is generally carried in a reverberatory or blast furnace.

50. (b) Lime stone which is a flux used to remove acidic impurities in metallurgical process.

52. (a) CN^- solution used in extraction of Ag metal in the cyanide process.

57. (c) Lime stone ($CaCO_3$) is used for formation of slag in *Fe* extraction

$$\underset{\text{Limestone}}{CaCO_3} \longrightarrow CaO + CO_2 \uparrow$$

$$CaO + \underset{\substack{\text{Gangue}\\ \text{or}\\ \text{impurity}}}{SiO_2} \longrightarrow \underset{\text{slag}}{CaSiO_3}$$

58. (a) $Cu_2S + 2Cu_2O \rightarrow 6Cu + SO_2$ (Auto-reduction).

This reaction occurs in reverberatory furnace to get metallic copper.

59. (b) Roasting involves heating of the ore either alone or with some other material usually in presence of air below its fusion temperature. In roasting, definite chemical changes like oxidation, chlorination etc., take place

$$S + O_2 \rightarrow SO_2$$

60. (a) Calcination $ZnCO_3 \rightarrow ZnO + CO_2$

Reduction to free metal

1. (c) Because Na is very reactive and can not be extracted by means of the reduction by *C, CO* etc. So extracted by electrolysis.

2. (a) Carbon reduction, $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$

3. (b) $\text{Flux} + \text{Gangue} \rightarrow \text{Slag}$

4. (b) Alumino thermite process involves reduction of oxides such as Fe_2O_3, Mn_3O_4, Cr_2O_3 etc. to metals with aluminum. $Cr_2O_3 + 2Al \rightarrow Al_2O_3 + 2Cr \;\; \Delta H = -\text{ve}$

5. (b) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

7. (a) A mixture of *Al* powder and metallic oxide (Cr_2O_3, Mn_3O_4 etc) is called thermite.

9. (b) *Al* is highly electropositive. It can be obtained by electrolytic reduction.

10. (d) $Fe_2O_3 + 3C \rightarrow 3CO + 2Fe$

13. (a) Bauxite into aluminium because Al is a strong reducing agent it has strong affinity with oxygen than carbon

20. (c) Electrolytic reduction Hall and Heroult process.

23. (b) $Fe_2O_3 + 3CO \rightarrow 3CO_2 + 2Fe$

24. (c) Self reduction :– Reduction of oxide ore of a metal by its own sulphide $2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$

26. (a) $ZnO + CO \rightarrow CO_2 + Zn$

27. (d) $2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$

$$3Cu_2O + \underset{\substack{\text{(From green}\\ \text{logs of wood)}}}{CH_4} \rightarrow 6Cu + 2H_2O + CO$$

30. (c) Sodium $\rightarrow$ Highly reactive metal

33. (a) $Cr_2O_3 + 2Al \rightarrow Al_2O_3 + 2Cr$

34. (a) In thermite process a mixture of aluminium powder and ferricoxide in the rate of 1 : 3 is used.

35. (b) Heating with carbon in absence of air is known as carbon reduction.

This is used in Iron metallurgy.

$$Fe_2O_3 + C \xrightarrow{\text{(in blast furnace)}} Fe$$

Refining of crude metal

2. (c) Van Arkel method *Ti* and *Zn* are refined by this method. It is used for obtaining ultra pure metals.

3. (b) Cupellation method is used when the impure metals contain impurity of another metal which forms volatile oxide.

4. (a) Metals are electropositive elements because they have tendency to loose e^- and forms + *ve* ions

$$Na \rightarrow Na^+ + e^-$$

6. (b) Impure metal as anode and pure metal as cathode.

7. (b) *Mg* and *Al* can not be obtained by the electrolysis of aqueous solution of their salts because instead of metal H_2 gas is liberated at cathode.

8. (a) $Ti + 2I_2 \xrightarrow{500\,K} \underset{\substack{\text{Volatile}\\ \text{Stable compound}}}{TiI_4} \xrightarrow{1700\,K} \underset{\text{Pure metal}}{Ti} + 2I_2$

9. (c) Zone refining is employed for preparing extremely pure metals.

It is based on the principle that when a molten solution of the impure metal is allowed to cool the pure metal crystallises out while the impurities remain in the melt. Ex : Semiconductors like *Si, Ge* and *Ga* are purified by this method.

10. (c) $\underset{\text{(fused)}}{2NaCl} \rightarrow 2Na^+ + 2Cl^-$

Anode: $2Cl^- \rightarrow 2e^- + Cl_2$ (oxidation)

Cathode: $2Na^+ + 2e^- \rightarrow 2Na -$ (reduction)

11. (b) Poling is used for purification of metal which contain their own oxide as impurity

e.g. Cu_2O in Cu ; SnO_2 in Sn

12. (c) Cupellation : If metal possess the impurity of another metal which forms volatile oxide. Then cupellation method is used.

16. (a) Mond's process

$$\underset{\text{Impure}}{Ni} + 4CO \xrightarrow{\text{heat}} [Ni(CO)_4] \xrightarrow{\text{Decompose}} \underset{\text{Pure}}{Ni} + 4CO$$

17. (c) Hydrometallurgy is the process of dissolving the metal or its ore by the action of a suitable chemical regent followed by recovery of the metal either by electrolysis or by the use of a suitable precipitating agent.

$$4Au + 8KCN + 2H_2O + \underset{\text{air}}{O_2} \rightarrow 4K[Au(CN)_2] + 4KOH$$

$$2K[Au(CN)_2] + Zn \rightarrow 2Au + K_2[Zn(CN)_4]$$

Critical Thinking Questions

1. (c) Black Jack (ZnS), also called zinc blend, is an ore of Zinc.

2. (a) Chalcopyrities is contain sulphur that's why it is concentrated by froth floatation process.

3. (a) Removal of silicious matter from ores is known as dressing or concentration of ore.

4. (b) Wolframite ore $[FeWO_4]$ is present in tin stone as impurities and it has same mass per unit volume as that of tin stone. So it is separated by electromagnetic separator because wolframite is magnetic in nature hence it gets attracted by magnet while tin stone doesn't

5. (b) Auto reduction is used for the extraction of copper from its ore with low copper content.

6. (b) PbO & $PbSO_4$ get reduced by *PbS* itself which is already present in mixture so because the reduction took place by mixture itself, hence is known as self reduction.

$$2PbO + PbS \xrightarrow{\Delta} 3Pb + SO_2 \uparrow$$

$$PbSO_4 + PbS \xrightarrow{\Delta} 2Pb + 2SO_2 \uparrow$$

7. (d) Zone refining is a method of purification used for semiconductors like Si, Ge and *Ga*.

8. (d) By the process of zone refining pure silicon is obtained which is used in semiconductor.

9. (d) $MgCO_3$ is the formula of magnesite.

10. (a) Lapis lazuli is the aluminium silicate present in earth rocks as blue stone.

Assertion and Reason

2. (e) Iron is highly reactive element, therefore, it is found in combined state. Here assertion is false but reason is true.

3. (a) Both assertion and reason are true and reason is the correct explanation of assertion.

4. (b) Both assertion and reason are true but reason is not the correct explanation of assertion. Non fusible mass present in ore in mixing with suitable flux are fused which are then reduced by coke to give free metal.

5. (c) Assertion is false but reason is true. Leaching is a process of concentration.

6. (c) Assertion is true but reason is false. Collectors absorbs themselves on polar groups to grains of ores and thus derive them on the surface to pass on into the froth.

7. (c) Assertion is true but reason is false.

Oxide ores being heavier than the earthy or rocky gangue particles settle down while lighter impurities are washed away.

8. (a) Both assertion and reason are true and reason is the correct explanation of assertion

9. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.

Silver nitrate is called lunar caustic because when it comes in contact with organic substances (e.g. skin, clothes) and reduced to metallic silver which is white like the iron lunar.

10. (c) Assertion is true but reason is false.

Wolframite being magnetic is attracted by the magnetic roller and forms a heap under it.

11 (a) Both assertion and reason are true and reason is correct and reason is the correct explanation of assertion.

Liquation process is based on the difference in fusibility of the metal and impurities. When the impurities are less fusible than the metal itself, the process is employed.

12. (a) Au is recovered from the solution by the addition of electropositive metal.

$$2NaAu(Cu)_2 + Zn \longrightarrow \underset{\text{Soluble complex}}{Na_2Zn(CN)_4}\ 2Au \downarrow$$