SOLUTION TEST-A

1. Van Arkel method is used for refining of Ti, Zr.

   Distillation → Zn, Liquation → Tin

   The correct answer is (ii)

2. Cassiterite → SnO_2

   Zincite → Zinc and manganese oxide

   Cuprite → Copper oxide

   Calamine → $ZnCO_3$

   Siderite → $FeCO_3$

   Galena → PbS

   The correct answer is (ii)

3. Impure copper ore is called copper matte, Cu_2S + FeS

   The correct answer is (i)

4. Reason is wrong. Silica act as an acidic flux and converts FeO into $FeSiO_3$.

   The correct answer is (iii)

5. Anode: $C + O^{2-} \rightarrow CO + 2e^-$

   $C + 2O_2 \rightarrow CO_2 + 3r^-$

   Cathode: $Al^{3+} + 3e^- \rightarrow Al$

   The correct answer is (i)

6. Pine oil is a froth collector. It enhances the wattability of the ore particles.

7. Liquation is based on the principle that the metal and impurities should have difference in their melting points.

8. (i) Impure copper ore contains FeO as a gangue. To remove this as a fusible slag, we use SiO_2 as s flux.

   $FeO + SiO_2 \rightarrow FeSiO_3$

   gangue flux slag

   That's why we put impure copper ore in a silica lined converter.

   (ii) Tungsten has a very high melting point. It provides a surface to decompose volatile $Ti I_4$ or $Zr I_4$ to the respective metal.

9. In the leaching process, first we convert the impure silver or gold to their cyano complex. This step is called oxidation of metal from zero oxidation state to + 1 oxidation state.

   $4M + 8NaCN + 2H_2O + O_2 \rightarrow 4Na [M(CN)_2] + 4NaOH$

   impure (Ag or Au)

   The cyano complex is then reduced by zinc to give pure metal. This step is called reduction

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

10. (i) Low grade copper ore is leached with hot and conc. H_2SO_4 which converts copper into $CuSO_4$. This $CuSO_4$ is then reduced to copper by H_2 or Zn

$Cu^{2+} + H_2 \rightarrow Cu + 2H^+$

(ii) $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$ (roasting)

$ZnO + C \rightarrow Zn + CO$ (reduction)

11. (i) For metallurgical operation, ΔH is positive. If metal is obtained in the molten or in the vapour form then ΔS = +ve and $T\Delta S$ terms dominates over ΔH and makes the ΔG = – ve. The metallurgical operations are entropy driven reaction.

(ii) MgO is basic flux and helps in removing the acidic gangue SiO_2.

$SiO_2 + MgO \rightarrow MgSiO_3$

gangue flux slag

(iii) H_2SO_4 is added to $CuSO_4$ to increase its electrical conductivity.

12. (i) $3Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$

$Fe_3O_4 + 4CO \rightarrow 3Fe + 4CO_2$

$Fe_2O_3 + CO \rightarrow 2FeO + CO_2$

(ii) Pig iron obtained from blast furnace contains about 4% of carbon and many other impurities such as S, P, Si and Mn. It can be cast into variety of shapes in moulds. Cast iron is made by igniting pig iron with iron scrap and coke. It contains about 3% carbon. It is extremely hard, brittle and cannot be welded.

13. (i) **Zone refining:** This method is used to obtain ultra pure germanium or silicon. The principle of zone refining is that the impurities are more soluble in molten metal than in solid metal. In another words, when an impure metal in the molten state allowed to cool, only the metal crystallizes while the impurities remains present in the molten mass or melt.

(ii) **Hydraulic washing:** This process is used in those cases in which the gangue particles are lighter than the ore and can be simply removed by washing with a stream of running water. The heavier ore particles are settle down. This process is used for tin ore.

14. (i) Cryolite role is to lower the melting point of Al_2O_3 and increases its electrical conductivity.

(ii) Carbon monoxide converts the impure nickel into its volatile tetracarbonyl nickel which then decomposes to give pure nickel. Carbon monoxide is also called a complexing agent.

(iii) Graphite rods (carbon) converts the O_2 into CO_2 at anode and prevent the oxidation of Al back to Al_2O_3.

$C + 2O^{2-} \rightarrow CO_2 + 4e^-$

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

$\Delta_r G° = \Delta_f G° Al_2O_3 - \Delta_f G° Cr_2O_3$

$= – 827 – (–540)$

$\Delta_r G° = – 287$ KJ/mol

(ii) The above reaction does not take place at 25°C even though $\Delta G°$ is negative because the reactants are not able to cross the energy of activation barrier.

(b) $Al_2O_3.2H_2O \xrightarrow{Heat} Al_2O_3 + 2H_2O \uparrow$

bauxite

main impurity is SiO_2

$Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2Na\,[Al(OH)_4]$ (Sodium aluminate)

$Al_2O_3 + 2NaOH + 2H_2O \rightarrow Na_2\,[Si(OH)_6]$ (Sodium silicate)

$Na[Al(OH)_4] \xrightarrow[dilution]{H_2O} NaOH + Al(OH)_3$

soluble white ppt

$2Al(OH)_3 \xrightarrow[1473K]{Heat} Al_2O_3 + 3H_2O$

pure

