NCERT EXRECISES

6.1. Copper can be extracted by hydrometallurgy but not zinc. Explain.
Ans:

Copper can be extracted by hydrometallurgy but not zinc, this is because $E^{\circ}_{Zn^{2+}/Zn} = -0.76$ V is lower than that of $E^{\circ}_{Cu^{2+}/Cu} = 0.34$ V. Hence, zinc can displace Cu from solutions of Cu^{2+} ions.

$$Zn(s) + Cu^{2+}(aq) \longrightarrow Zn^{2+}(aq) + Cu(s)$$

In order to displace zinc from zinc solution, a more reactive metal is required, such as Al ($E^{\circ}_{Al^{3+}/Al} = -1.66$ V), Mg ($E^{\circ}_{Mg^{2+}/Mg} = -2.37$ V), Ca ($E^{\circ}_{Ca^{2+}/Ca} = -2.87$ V), K ($E^{\circ}_{K^{+}/K} = -2.93$ V).

But with water, these metals (Al, Mg, Ca and K) forms their corresponding ions with the evolution of H_2 gas.
Thus, Al, Mg, Ca, K, etc., cannot be used to displace zinc from zinc solution, and only copper can be extracted by hydrometallurgy but not the zinc.

6.2. What is the role of depressant in froth-floatation process?
Ans: The role of depressant is to prevent one type of sulphide ore particles from forming the froth with air bubbles. NaCN is used as a depressant to separate lead sulphide (PbS) ore from zinc sulphide (ZnS) ore. NaCN forms a zinc complex, $Na_2[Zn(CN)_4]$ on the surface of ZnS thereby preventing it from the formation of the froth.

$$4NaCN + ZnS \longrightarrow \underset{\text{Sodium tetracyano-zincate (II)}}{Na_2[Zn(CN)_4]} + Na_2S$$

In this condition, only lead sulphide forms froth and thus can be separated from zinc sulphide ore.

6.3. Why is the extraction of copper from pyrites more difficult than that from its oxide ore through reduction?
Ans:

$\Delta_f G^\circ$ of Cu_2S is more negative than $\Delta_f G^\circ$ of CS_2 and H_2S. So Cu_2S can not be reduced by carbon or hydrogen. $\Delta_f G^\circ$ of CO_2 is more negative than $\Delta_f G^\circ$ of Cu_2O. So Cu_2O can be reduced by carbon. So pyrites is first converted to oxide before reduction to copper.

$$Cu_2S(s) + \frac{3}{2}O_2(g) \rightarrow Cu_2O(s) + SO_2(g)$$

$$Cu_2O(s) + C(s) \longrightarrow 2Cu(s) + CO(s)$$

6.4. Explain:
(i) Zone refining
(ii) Column chromatography.
Ans:
(i) Zone refining: This method is used for production of semiconductors and other metals of very high purity, e.g., Ge, Si, B, Ca and In.
It is based on the principle that the impurities are more soluble in the molten state (melt) than in the solid state of the metal.
The impure metal in the form of bar is heated at one end with a moving circular heater. As - the heater is slowly moved along the length of the rod, .the pure metal crystallises out of the melt whereas the impurities pass into the adjacent molten zone. Thi,s process is repeated several times till the impurities are completely driven to one end of the rod which is then cut off and discarded.
(ii) Chromatography: It is based on the principle that the different components of a mixture are adsorbed to different extents on an adsorbent.
In column chromatography, an adsorbent, such as alumina (Al_2O_3) or silica gel is packed in a column. This fonns the stationary phase. The mixture to be separated is dissolved in a suitable solvent (mobile phase) and applied to the top of the column. The adsorbed components are extracted (eluted) from the column with a suitable . solvent (eluent). The component which is more strongly adsorbed on the column takes longer time to travel through the column than a component which is weakly adsorbed. Thus, the various components of the mixture are seperated as they travel through absorbent (stationary phase).

6.5. Out of C and CO which is a better reducing agent at 673 K?
Ans: This can be explained thermodynamically, taking entropy and free energy changes into account.

(a) $C(s) + O_2(g) \longrightarrow CO_2(g)$

(b) $2C(s) + O_2(g) \longrightarrow 2CO(g)$

Case (i): Volume of CO_2 produced = Volume of O_2 used.

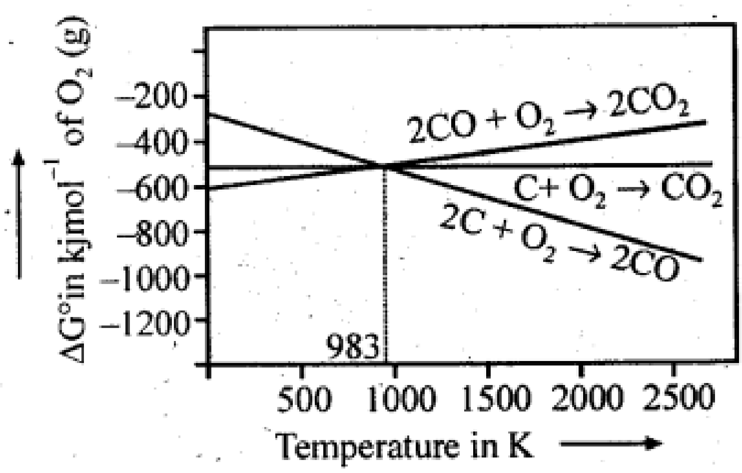
$\therefore$ ΔS is very small and ΔG does not change with temperature.

$\therefore$ Plot of ΔG Vs T is almost horizontal.

Case (ii): Volume of CO produced = 2 × Volume of O_2 used.

$\therefore$ ΔS is positive and hence ΔG becomes increasingly negative as the temperature increases.

$\therefore$ Plot of $\Delta^\circ G$ Vs T slopes downwards.



As can be seen from ΔG° Vs T plot (Ellingham diagram), lines for the reactions, C → CO_2 and C → CO cross at 983 K. Below 983 K, the reaction (a) is energetically more favourable but above 673 K, reaction (b) is favourable and preferred. Thus, below 673 K both C and CO can act as a reducing agent but since CO can be more easily oxidised to CO_2 than C to CO_2 , therefore, below 673 K, CO is more effective reducing agent than carbon.

6.6. Name the common elements present in the anode mud in electrolytic refining of copper. Why are they so present?
Ans. The common elements present in the anode mud are antimony, selenium, tellurium, silver, gold and platinum. These elements settle down under anode as anode mud because they are less reactive and are not effected by $CuSO_4$ - H_2SO_4 solution.

6.7. Write down the reactions taking place in different zones in the blast furnace during the extraction of iron.
Ans. In the blast furnace reduction of iron oxides take place at different temperature ranges as shown below.

At 500 – 800 K

$$3Fe_2O_3 + CO \longrightarrow 2Fe_3O_4 + CO_2$$

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

$$Fe_2O_3 + CO \longrightarrow 2FeO + CO_2$$

At 900 – 1500 K

$$C + CO_2 \longrightarrow 2CO$$

$$FeO + CO \longrightarrow Fe + CO_2$$

$$C + O_2 \longrightarrow CO_2$$

Above 1570 *K*

$$FeO + C \longrightarrow Fe + CO$$

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$

$$CaO + SiO_2 \longrightarrow CaSiO_3\,(slag)$$

The following reactions occur in the blast furnace:

(*a*) In zone of combustion,

$$C + O_2 \longrightarrow CO_2, \Delta H = -393{\cdot}3\ kJ$$

(*b*) In zone of heat absorption,

$$CO_2 + C \longrightarrow 2CO, \Delta H = +163{\cdot}2\ kJ$$

(*c*) In zone of slag formation,

$$CaCO_3 \longrightarrow CaO + CO_2$$

$$CaO + SiO_2 \longrightarrow \underset{\substack{\text{Calcium silicate} \\ \text{(Slag)}}}{CaSiO_3}$$

(*d*) In zone of reduction,

$$Fe_2O_3 + CO \xrightarrow{823K} 2FeO + CO_2$$

$$Fe_3O_4 + CO \xrightarrow{823K} 3FeO + CO_2$$

$$Fe_2O_3 + 3C \xrightarrow{>1123K} 2Fe + 3CO$$

6.8. Write chemical reactions taking place in the extraction of zinc from zinc blende.

Ans: The following processes are involved in the extraction of zinc from zinc blende:

(i) Concentration: Zinc blende ore is crushed and the concentration done by froth- floatation process.
(ii) Roasting: The concentrated ore is then roasted in presence of excess of air at about 1200 K as a result zinc oxide is formed.

$$\underset{\text{Zinc blende}}{2ZnS} + 3O_2 \xrightarrow{\Delta} \underset{\text{Zinc oxide}}{2ZnO} + 2SO_2$$

(iii) Reduction : Zinc oxide obtained above is mixed with powdered coke and heated to 1673 K in a fire clay retort where it is reduced to zinc metal.

$$ZnO + C \xrightarrow{1673\ K} Zn + CO$$

At 1673 K, zinc metal being volatile (boiling point 1180 K), distills over and is condensed.
(iv) Electrolytic refining: Impure zinc is made the anode while pure zinc strip is made the cathode. $ZnSO_4$ solution acidified with dil. H_2SO_4 is the electrolyte used. On passing electric current, pure zinc gets deposited on the cathode.

6.9. State the role of silica in the metallurgy of copper.
Ans: During roasting, copper pyrites are converted into a mixture of FeO and Cu_2O. Thus, acidic flux silica is added during smelting to remove FeO (basic). FeO combines with SiO_2 to form famous silicate ($FeSiO_3$) slag which floats over molten matte.

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