CBSE Class 12 physics

Important Questions

Chapter 6

General Principles and Processes of Isolation of Elements

2 Marks Questions

1. Sulphide and carbonate ores are converted to oxide before reduction. Why?

Ans. Since the reduction of oxide ores involves a decrease in Gibb's free energy making ΔG value more negative, it is easier to reduce oxides therefore suphide and carbonate ores are converted to oxides before reduction.

2. What is calcinations and roasting? Give one example of each?

Ans. Calcination:- It is the process of heating carbonate ore in the absence of air when volatile matter escape leaving behind metal oxide . e.g.

$$Zn\,CO_3(s) \xrightarrow{\Delta} ZnO(s) + CO_2(g)$$

$$CaCO_3 - Mg\ CO_3 \xrightarrow{\Delta} CaO(s) + MgO(s) + 2CO_2(g)$$

Roasting :- Here ore is heated in a regular supply of air at a temperature below the melting point of metal e.g.

$$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$$

$$2PbS + 3O_2 \rightarrow 2PbO + 2SO_2$$

3. What is slag? Give an example.

Ans. Slag is the substance obtained after flux reacts with impurity.

Flux + Impurity $\rightarrow$ Slag.

For example silica is added as flux to remove iron oxide during extraction of copper as ferrous silicate.

$FeO + SiO_2 \rightarrow FeSiO_3\,(slag)$

Impurity flux

4. How does a reducing agent helps in reduction?

Ans. During the reduction of the metal oxide, the reducing agent combines with oxygen of metal oxide and gets itself oxidized.

$M_xO_y + {}_yC \rightarrow {}_xM + {}_yCO$ Here carbon is reducing agent.

5. Write the relationship between Gibbs free energy, enthalpy change and change in entropy?

Ans. When ΔS is entropy change, ΔH is enthalpy change , than at temperature T, the change in Gibbs free energy is given by

$\Delta G = \Delta H - T\Delta S$.

6. What is the condition for a reduction reaction to occur in terms of free energy change? How can it be achieved?

Ans. When the value of ΔG is negative, the reduction reaction is said to be spontaneous

1) If ΔS is positive, on increasing the temperature, the value of $T\Delta S$ would increase & ΔG will become negative.

2) For a process which is otherwise having ΔG positive & is non- spontaneous, it can be coupled with a reaction having highly negative ΔG value so that the overall ΔG is negative and the process can take place.

7. What are Ellingham diagrams?

Ans. Ellingham diagrams are graphical representation of variation of ΔG vs T for the formation of oxides of elements i.e., for the reaction

$2xM(S) + O_2(g) \rightarrow 2MxO(gs)$

8. Give the requirements for vapour phase refining?

Ans. The two requirements of vapour phase refining are:-

1) The metal should form a volatile compound with an available reagent,

2) The volatile compound should be easily decomposable so that recovery is easy.

9. What is the basis of reduction of a molten metal salt? Explain

Ans. In the reduction of molten metal salt, electrolysis is done which is based on electrochemical principles following equation $\Delta G = -nFE^0$

Here n is the number of electrons and E^0 is the electrode potential of redox couple. More reactive metals have large negative values of the electrode potential and are difficult to reduce.

10. Which of the ores mentioned in Table 6.1 can be concentrated by magnetic separation method?

Ans. If the ore or the gangue can be attracted by the magnetic field, then the ore can be concentrated by the process of magnetic separation. Among the ores mentioned in table 6.1, the ores of iron such as haematite $\left(Fe_2O_3\right)$, magnetite $\left(Fe_3O_4\right)$, siderite $\left(FeCO_3\right)$ and iron pyrites $\left(FeS_2\right)$ can be separated by the process of magnetic separation.

11. The reaction, $Cr_2O_3 + 2Al \rightarrow Al_2O_3 + 2Cr\left(\Delta G_0 = -421kJ\right)$ is thermodynamically feasible as is apparent from the Gibbs energy value. Why does it not take place at room temperature?

Ans. The change in Gibbs energy is related to the equilibrium constant, *K* as
$\Delta G = -RT \ln K$

At room temperature, all reactants and products of the given reaction are in the solid state. As a result, equilibrium does not exist between the reactants and the products. Hence, the reaction does not take place at room temperature. However, at a higher temperature, chromium melts and the reaction takes place.

We also know that according to the equation

$\Delta G = \Delta H - T\Delta S$

Increasing the temperature increases the value of $T\Delta S$ making the value of ΔG more and more negative. Therefore, the reaction becomes more and more feasible as the temperature is increased.

12. Is it true that under conditions, Mg can reduce SiO_2 and Si can reduce MgO? What are those conditions

Ans. $Mg_{(l)} + \frac{1}{2}O_{(g)} \longrightarrow MgO_{(l)} \left[\Delta G_{(Mg, MgO)}\right]$

$Si_{(s)} + O_{2(g)} \longrightarrow SiO_2 \left[\Delta G_{(Si, SiO_2)}\right]$

The temperature range in which $\Delta G_{(Mg, MgO)}$ is lesser than $\Delta G_{(Si, SiO_2)}$, Mg can reduce SiO_2 to Si.

$2Mg + SiO_2 \longrightarrow 2MgO + Si; \Delta G^{\circ} = -ve$

On the other hand, the temperature range in which $\Delta G_{(Si, SiO_2)}$ is less than $\Delta G_{(Mg, MgO)}$, Si can reduce MgO to Mg.

$SiO_2 + 2Mg \longrightarrow SiO_2 + 2Mg; \Delta G^{\circ} = -ve$

The temperature at which $\Delta_f G$ curves of these two substances intersect is 1966 K. Thus, at temperature less than 1966 K, Mg can reduce SiO_2 and above 1966 K, Si can reduce MgO.

13. Copper can be extracted by hydrometallurgy but not zinc. Explain.

Ans. The reduction potentials of zinc and iron are lower than that of copper. In hydrometallurgy, zinc and iron can be used to displace copper from their solution.

$Fe_{(s)} + Cu^{2+}_{(aq)} \rightarrow Fe^{2+}_{(aq)} + Cu_{(s)}$

But to displace zinc, more reactive metals i.e., metals having lower reduction potentials than zinc such as Mg, Ca, K, etc. are required. But all these metals react with water with the evolution of H_2 gas.

$$2K_{(s)} + 2H_2O_{(l)} \rightarrow 2KOH_{(aq)} + H_{2(g)}$$

As a result, these metals cannot be used in hydrometallurgy to extract zinc.

Hence, copper can be extracted by hydrometallurgy but not zinc.

14. Out of C and CO, which is a better reducing agent at 673 K?

Ans. At 673 K, the value of $\Delta G_{(CO,CO_2)}$ is less than that of $\Delta G_{(C,CO)}$. Therefore, CO can be oxidised more easily to CO_2 than C to CO. Hence, CO is a better reducing agent than C at 673 K.

15. Name the common elements present in the anode mud in electrolytic refining of copper. Why are they so present?

Ans. In electrolytic refining of copper, the common elements present in anode mud are selenium, tellurium, silver, gold, platinum, and antimony.

These elements are very less reactive and are not affected during the purification process. Hence, they settle down below the anode as anode mud.

16. What is meant by the term "chromatography"?

Ans. Chromatography is a collective term used for a family of laboratory techniques for the separation of mixtures. The term is derived from Greek words 'chroma' meaning 'colour' and 'graphein' meaning 'to write'. Chromatographic techniques are based on the principle that different components are absorbed differently on an absorbent. There are several chromatographic techniques such as paper chromatography, column chromatography, gas chromatography, etc.

17. What criterion is followed for the selection of the stationary phase in chromatography?

Ans. The stationary phase is selected in such a way that the components of the sample have different solubility's in the phase. Hence, different components have different rates of movement through the stationary phase and as a result, can be separated from each other.

18. Describe a method for refining nickel.

Ans. Nickel is refined by Mond's process. In this process, nickel is heated in the presence of carbon monoxide to form nickel tetracarbonyl, which is a volatile complex.

$$Ni + 4CO \xrightarrow{330-350K} \underset{\text{Nickel tetracarbonyl}}{Ni(CO)_4}$$

Then, the obtained nickel tetracarbonyl is decomposed by subjecting it to a higher temperature (450 - 470 K) to obtain pure nickel metal.

$$\underset{\text{Nickel tetracarbonyl}}{Ni(CO)_4} \xrightarrow{330-350K} \underset{\text{Nickel}}{Ni} + 4CO$$

19. How is 'cast iron' different from 'pig iron"?

Ans. The iron obtained from blast furnaces is known as pig iron. It contains around 4% carbon and many impurities such as S, P, Si, Mn in smaller amounts.

Cast iron is obtained by melting pig iron and coke using a hot air blast. It contains a lower amount of carbon (3%) than pig iron. Unlike pig iron, cast iron is extremely hard and brittle.

20. Differentiate between "minerals" and "ores".

Ans. Minerals are naturally occurring chemical substances containing metals. They are found in the Earth's crust and are obtained by mining.

Ores are rocks and minerals viable to be used as a source of metal.

For example, there are many minerals containing zinc, but zinc cannot be extracted profitably (conveniently and economically) from all these minerals.

Zinc can be obtained from zinc blende (ZnS), calamine $(ZnCO_3)$, Zincite (ZnO) etc.

Thus, these minerals are called ores of zinc.

21. How is leaching carried out in case of low grade copper ores?

Ans. In case of low grade copper ores, leaching is carried out using acid or bacteria in the presence of air. In this process, copper goes into the solution as Cu^{2+} ions.

$$Cu_{(s)} + 2H^{+}_{(aq)} + \frac{1}{2}O_{2(g)} \rightarrow Cu^{2+}_{(aq)} + 2H_2O_{(l)}$$

The resulting solution is treated with scrap iron or H_2 to get metallic copper.

$$Cu^{2+}_{(aq)} + H_{2(g)} \rightarrow Cu_{(s)} + 2H^{+}_{(aq)}$$