Intext Questions

Question 6.1:

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

Answer

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 (Fe_2O_3), magnetite (Fe_3O_4), siderite ($FeCO_3$), and iron pyrites (FeS_2) can be separated by the process of magnetic separation.
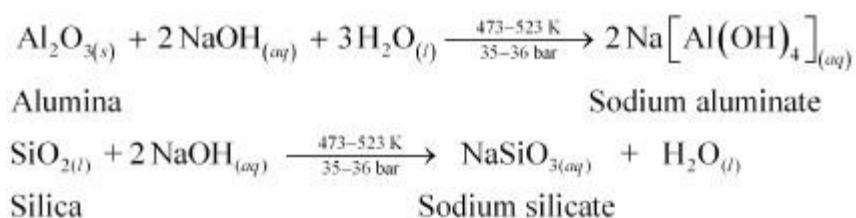
Question 6.2:

What is the significance of leaching in the extraction of aluminium?

Answer

In the extraction of aluminium, the significance of leaching is to concentrate pure alumina (Al_2O_3) from bauxite ore.

Bauxite usually contains silica, iron oxide, and titanium oxide as impurities. In the process of leaching, alumina is concentrated by digesting the powdered ore with a concentrated solution of NaOH at 473-523 K and 35-36 bar. Under these conditions, alumina (Al_2O_3) dissolves as sodium meta-aluminate and silica (SiO_2) dissolves as sodium silicate leaving the impurities behind.

$$Al_2O_{3(s)} + 2NaOH_{(aq)} + 3H_2O_{(l)} \xrightarrow[35-36\,bar]{473-523\,K} 2Na\left[Al(OH)_4\right]_{(aq)}$$
Alumina　　　　　　　　　　　　　　　Sodium aluminate

$$SiO_{2(l)} + 2NaOH_{(aq)} \xrightarrow[35-36\,bar]{473-523\,K} NaSiO_{3(aq)} + H_2O_{(l)}$$
Silica　　　　　　　　　Sodium silicate

The impurities are then filtered and the solution is neutralized by passing CO_2 gas. In this process, hydrated Al_2O_3 gets precipitated and sodium silicate remains in the solution. Precipitation is induced by seeding the solution with freshly prepared samples
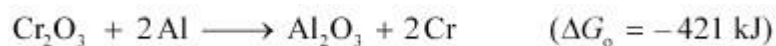
of hydrated Al_2O_3.

$$2\,Na\left[Al(OH)_4\right]_{(aq)} + CO_{2(g)} \longrightarrow Al_2O_3.xH_2O_{(s)} + 2\,NaHCO_{3(aq)}$$
$$\text{Hydrated alumina}$$

Hydrated alumina thus obtained is filtered, dried, and heated to give back pure alumina (Al_2O_3).

$$Al_2O_3.xH_2O_{(s)} \xrightarrow{1470K} Al_2O_{3(s)} + xH_2O_{(g)}$$
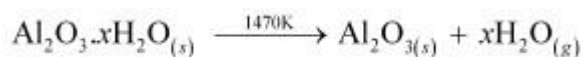
Question 6.3:

The reaction,

$$Cr_2O_3 + 2\,Al \longrightarrow Al_2O_3 + 2\,Cr \qquad (\Delta G_o = -421\ kJ)$$

is thermodynamically feasible as is apparent from the Gibbs energy value.

Why does it not take place at room temperature?

Answer

The change in Gibbs energy is related to the equilibrium constant, K as

$$\Delta G = -R\,T\ln K$$.

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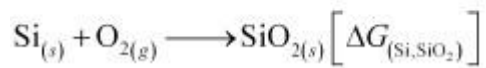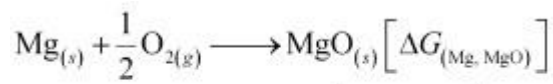
$$\Delta G = \Delta H - T\Delta S,$$

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.
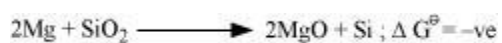
Question 6.4:

Is it true that under certain conditions, Mg can reduce SiO_2 and Si can reduce MgO?

What are those conditions?

Answer

$$\text{Mg}_{(s)} + \frac{1}{2}\text{O}_{2(g)} \longrightarrow \text{MgO}_{(s)} \left[\Delta G_{(\text{Mg, MgO})} \right]$$

$$\text{Si}_{(s)} + \text{O}_{2(g)} \longrightarrow \text{SiO}_{2(s)} \left[\Delta G_{(\text{Si, SiO}_2)} \right]$$

The temperature range in which $\Delta G_{(\text{Mg, MgO})}$ is lesser than $\Delta G_{(\text{Si,SiO}_2)}$, Mg can reduce SiO_2 to Si.

$$2\text{Mg} + \text{SiO}_2 \longrightarrow 2\text{MgO} + \text{Si} \; ; \Delta G^{\ominus} = -ve$$

On the other hand, the temperatures range in which $\Delta G_{(\text{Si,SiO}_2)}$ is less than $\Delta G_{(\text{Mg, MgO})}$, Si can reduce MgO to Mg.

$$\text{SiO}_2 + 2\text{Mg} \longrightarrow \text{SiO}_2 + 2\text{Mg} \; ; \Delta G^{\ominus} = -ve$$

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