

## CBSE Class 12 physics

### Important Questions

#### Chapter 6

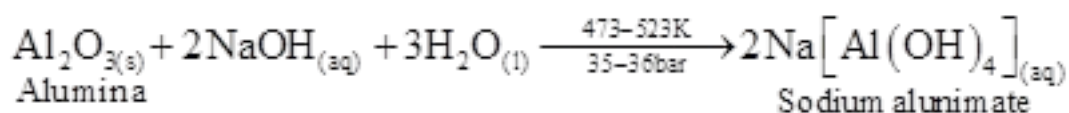
#### General Principles and Processes of Isolation of Elements

#### 5 Marks Questions

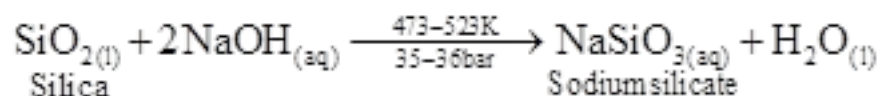
#### 1. What is the significance of leaching in the extraction of aluminium?

**Ans.** In the extraction of aluminium, the significance of leaching is to concentrate pure alumina ( $\text{Al}_2\text{O}_3$ ) from bauxite ore.

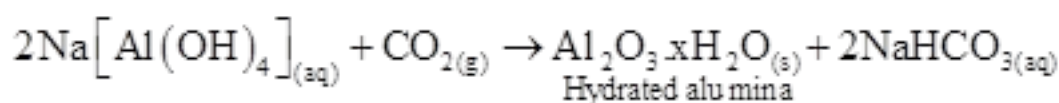
Bauxite usually contains silica, iron oxide, and titanium oxide as impurities. In the process of leaching, alumina is concentrated by digesting the powdered ore with a concentrated solution of NaOH at 473-523 K and 35-36 bar. Under these conditions, alumina ( $\text{Al}_2\text{O}_3$ ) dissolves as sodium meta-aluminate and silica ( $\text{SiO}_2$ ) dissolves as sodium silicate leaving the impurities behind.



Alumina

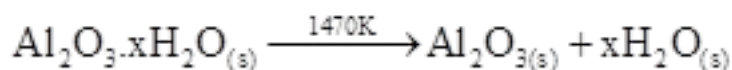


The impurities are then filtered and the solution is neutralized by passing  $\text{CO}_2$  gas. In this process, hydrated ( $\text{Al}_2\text{O}_3$ ) gets precipitated and sodium silicate remains in the solution. Precipitation is induced by seeding the solution with freshly prepared samples of hydrated ( $\text{Al}_2\text{O}_3$ ).



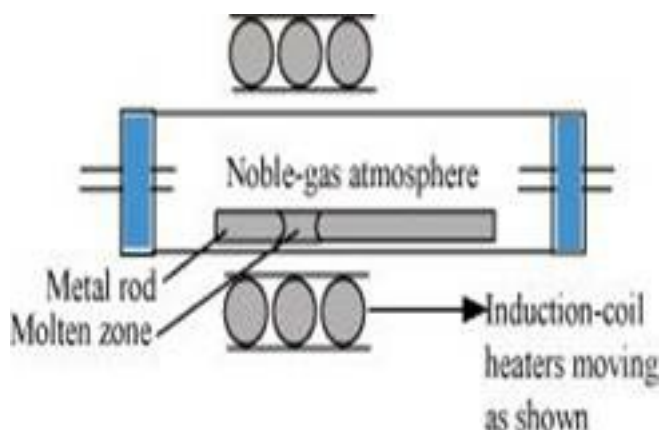
Hydrated alumina thus obtained is filtered, dried, and heated to give back pure alumina

$(\text{Al}_2\text{O}_3)$ .



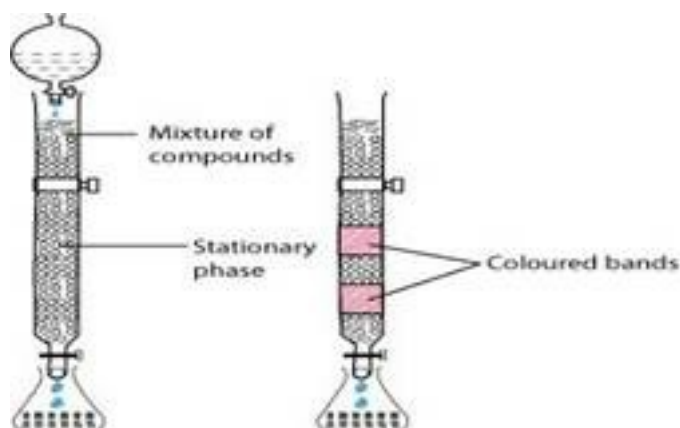
**2. Explain: (i) Zone refining (ii) Column chromatography.**

**Ans. (i) Zone refining:**



This method is based on the principle that impurities are more soluble in the molten state of metal (the melt) than in the solid state. In the process of zone refining, a circular mobile heater is fixed at one end of a rod of impure metal. As the heater moves, the molten zone of the rod also moves with it. As a result, pure metal crystallizes out of the melt and the impurities pass onto the adjacent molten zone. This process is repeated several times, which leads to the segregation of impurities at one end of the rod. Then, the end with the impurities is cut off. Silicon, boron, gallium, indium etc. can be purified by this process.

**(ii) Column chromatography:**

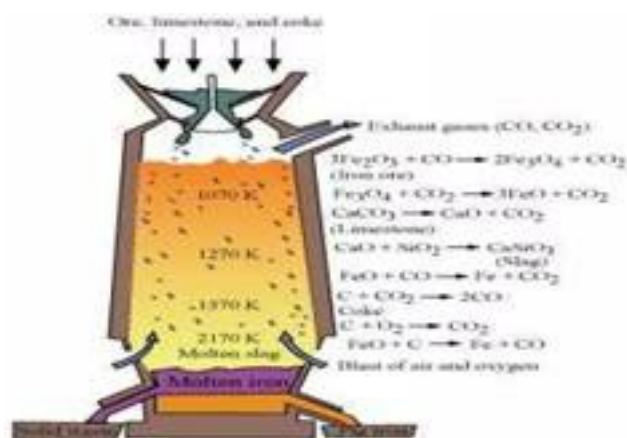


Column chromatography is a technique used to separate different components of a mixture.

It is a very useful technique used for the purification of elements available in minute quantities. It is also used to remove the impurities that are not very different in chemical properties from the element to be purified. Chromatography is based on the principle that different components of a mixture are differently adsorbed on an adsorbent. In chromatography, there are two phases: mobile phase and stationary phase. The stationary phase is immobile and immiscible.  $\text{Al}_2\text{O}_3$  column is usually used as the stationary phase in column chromatography. The mobile phase may be a gas, liquid, or supercritical fluid in which the sample extract is dissolved. Then, the mobile phase is forced to move through the stationary phase. The component that is more strongly adsorbed on the column takes a longer time to travel through it than the component that is weakly adsorbed. The adsorbed components are then removed (eluted) using a suitable solvent (eluant).

**3. Write down the reactions taking place in different zones in the blast furnace during the extraction of iron.**

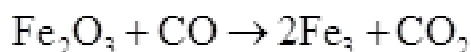
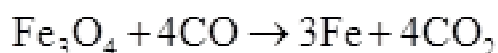
**Ans.**



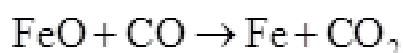
During the extraction of iron, the reduction of iron oxides takes place in the blast furnace. In this process, hot air is blown from the bottom of the furnace and coke is burnt to raise the temperature up to 2200 K in the lower portion itself. The temperature is lower in the upper part. Thus, it is the lower part where the reduction of iron oxides ( $\text{Fe}_2\text{O}_3$  and  $\text{Fe}_3\text{O}_4$ ) takes place.

The reactions taking place in the lower temperature range (500 - 800 K) in the blast furnace are:

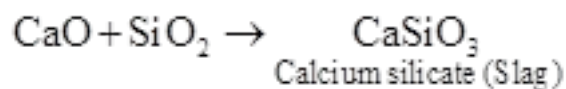




The reaction taking place in the higher temperature range (900 – 1500 K) in the blast furnace are:



The silicate impurities of the ore is removed as slag by calcium oxide (CaO), which is formed by the decomposition of limestone ( $\text{CaCO}_3$ ).



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

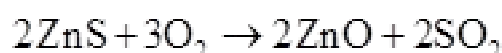
**Ans.** The different steps involved in the extraction of zinc from zinc blende (ZnS) are given below:

##### (i) Concentration of ore

First, the gangue from zinc blende is removed by the froth floatation method.

##### (ii) Conversion to oxide (Roasting)

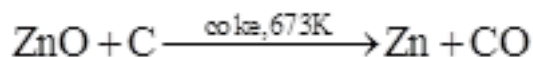
Sulphide ore is converted into oxide by the process of roasting. In this process, ZnS is heated in a regular supply of air in a furnace at a temperature, which is below the melting point of Zn.



##### (iii) Extraction of zinc from zinc oxide (Reduction)

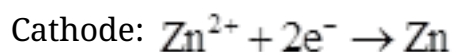
Zinc is extracted from zinc oxide by the process of reduction. The reduction of zinc oxide is

carried out by mixing it with powdered coke and then, heating it at 673 K.



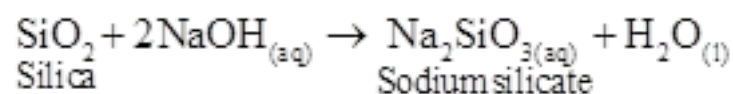
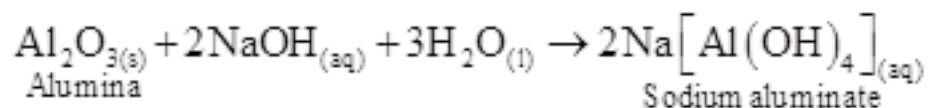
#### (iv) Electrolytic Refining

Zinc can be refined by the process of electrolytic refining. In this process, impure zinc is made the anode while a pure copper strip is made the cathode. The electrolyte used is an acidified solution of zinc sulphate ( $\text{ZnSO}_4$ ). Electrolysis results in the transfer of zinc in pure from the anode to the cathode.

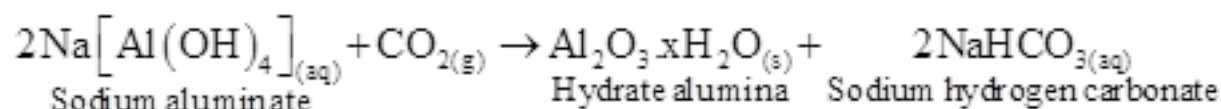


**5. How can you separate alumina from silica in bauxite ore associated with silica? Give equations, if any.**

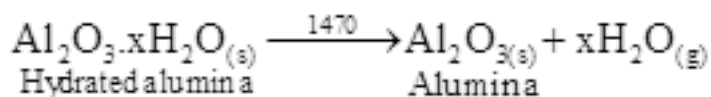
**Ans.** To separate alumina from silica in bauxite ore associated with silica, first the powdered ore is digested with a concentrated NaOH solution at 473 - 523 K and 35 - 36 bar pressure. This results in the leaching out of alumina ( $\text{Al}_2\text{O}_3$ ) as sodium aluminate and silica ( $\text{SiO}_2$ ) as sodium silicate leaving the impurities behind.



Then,  $\text{CO}_2$  gas is passed through the resulting solution to neutralize the aluminate in the solution, which results in the precipitation of hydrated alumina. To induce precipitation, the solution is seeded with freshly prepared samples of hydrated alumina.

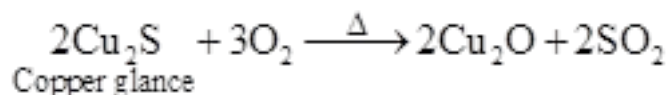
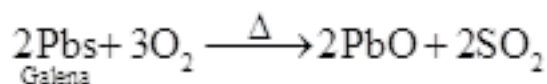
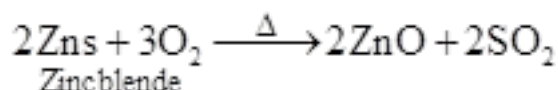


During this process, sodium silicate remains in the solution. The obtained hydrated alumina is filtered, dried, and heated to get back pure alumina.

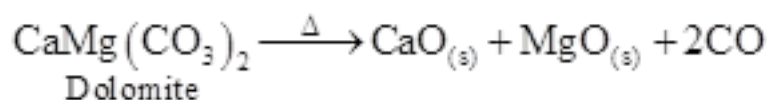
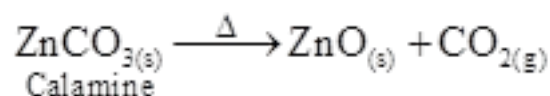
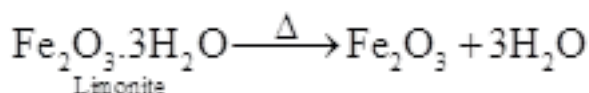


## 6. Giving examples, differentiate between 'roasting' and 'calcination'.

**Ans.** Roasting is the process of converting sulphide ores to oxides by heating the ores in a regular supply of air at a temperature below the melting point of the metal. For example, sulphide ores of Zn, Pb, and Cu are converted to their respective oxides by this process.

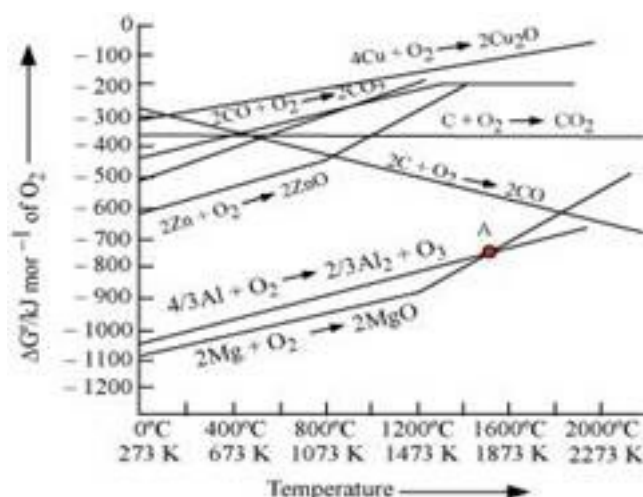


On the other hand, calcination is the process of converting hydroxide and carbonate ores to oxides by heating the ores either in the absence or in a limited supply of air at a temperature below the melting point of the metal. This process causes the escaping of volatile matter leaving behind the metal oxide. For example, hydroxide of Fe, carbonates of Zn, Ca, Mg are converted to their respective oxides by this process.



## 7. The choice of a reducing agent in a particular case depends on thermodynamic factor. How far do you agree with this statement? Support your opinion with two examples.

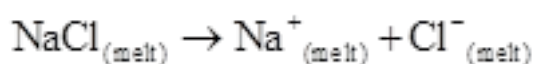
**Ans.**



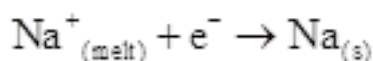
The above figure is a plot of Gibbs energy  $\Delta G^\ominus$  vs.  $T$  for formation of some oxides. It can be observed from the above graph that a metal can reduce the oxide of other metals, if the standard free energy of formation  $\Delta_f G^\ominus$  of the oxide of the former is more negative than the latter. For example, since  $\Delta_f G^\ominus_{(Al, Al_2O_3)}$  is more negative than  $\Delta_f G^\ominus_{(Cu, Cu_2O)}$ , Al can reduce  $Cu_2O$  to Cu, but Cu cannot reduce  $Al_2O_3$ . Similarly, Mg can reduce ZnO to Zn, but Zn cannot reduce MgO because  $\Delta_f G^\ominus_{(Mg, MgO)}$  is more negative than  $\Delta_f G^\ominus_{(Zn, ZnO)}$ .

**8. Name the processes from which chlorine is obtained as a by-product. What will happen if an aqueous solution of NaCl is subjected to electrolysis?**

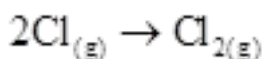
**Ans.** In the electrolysis of molten NaCl,  $Cl_2$  is obtained at the anode as a by product.



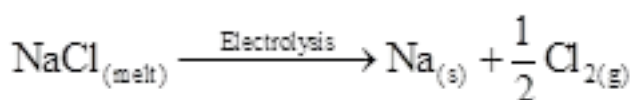
At cathode:



At anode:  $Cl^-_{(melt)} \rightarrow Cl_{(g)} + e^-$

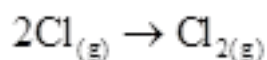
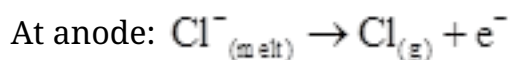
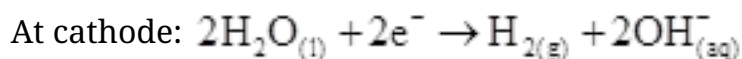
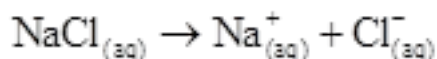


The overall reaction is as follows:



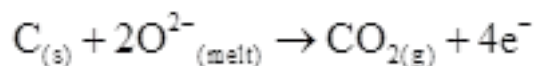
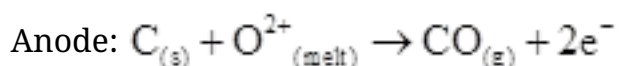
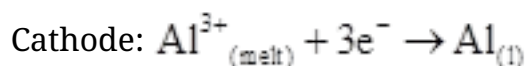


If an aqueous solution of NaCl is electrolyzed,  $\text{Cl}_2$  will be obtained at the anode but at the cathode,  $\text{H}_2$  will be obtained (instead of Na). This is because the standard reduction potential of Na  $E^\circ = -2.71\text{V}$  is more negative than that of  $\text{H}_2\text{O}$  ( $E^\circ = -0.83\text{V}$ ). Hence,  $\text{H}_2\text{O}$  will get preference to get reduced at the cathode and as a result,  $\text{H}_2$  is evolved.



### 9. What is the role of graphite rod in the electrometallurgy of aluminium?

**Ans.** In the electrometallurgy of aluminium, a fused mixture of purified alumina  $\text{Al}_2\text{O}_3$ , cryolite ( $\text{Na}_3\text{AlF}_6$ ) and fluorspar ( $\text{CaF}_2$ ) is electrolysed. In this electrolysis, graphite is used as the anode and graphite-lined iron is used as the cathode. During the electrolysis, Al is liberated at the cathode, while CO and  $\text{CO}_2$  are liberated at the anode, according to the following equation.



If a metal is used instead of graphite as the anode, then  $\text{O}_2$  will be liberated. This will not only oxidise the metal of the electrode, but also convert some of the Al liberated at the cathode back into  $\text{Al}_2\text{O}_3$ . Hence, graphite is used for preventing the formation of  $\text{O}_2$  at the anode. Moreover, graphite is cheaper than other metals.

### 10. Outline the principles of refining of metals by the following methods:

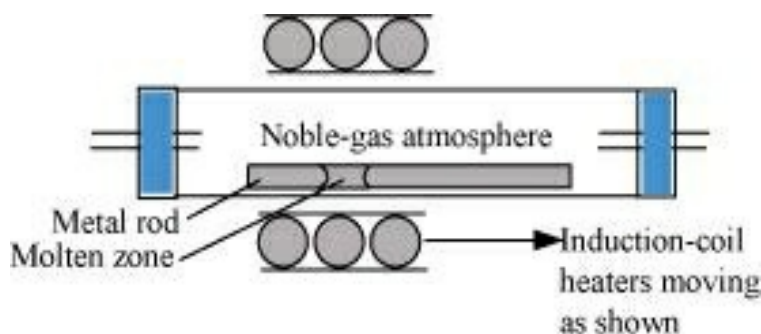
#### (i) Zone refining



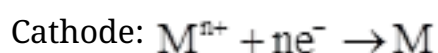
## (ii) Electrolytic refining

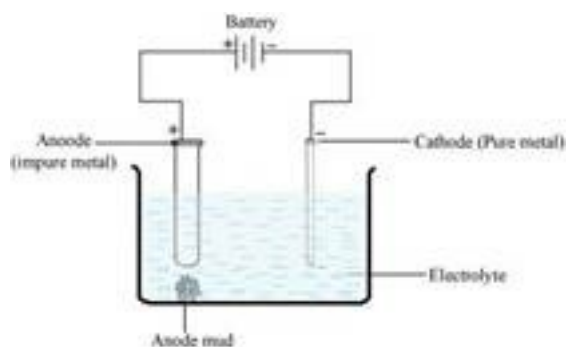
## (iii) Vapour phase refining

**Ans. (i) Zone refining:** This method is based on the principle that impurities are more soluble in the molten state of metal (the melt) than in the solid state. In the process of zone refining, a circular mobile heater is fixed at one end of a rod of impure metal. As the heater moves, the molten zone of the rod also moves along with it. As a result, pure metal crystallizes out of the melt and the impurities pass to the adjacent molten zone. This process is repeated several times, which leads to the segregation of impurities at one end of the rod. Then, the end with the impurities is cut off. Silicon, boron, gallium, indium etc. can be purified by this process.



**(ii) Electrolytic refining:** Electrolytic refining is the process of refining impure metals by using electricity. In this process, impure metal is made the anode and a strip of pure metal is made the cathode. A solution of a soluble salt of the same metal is taken as the electrolyte. When an electric current is passed, metal ions from the electrolyte are deposited at the cathode as pure metal and the impure metal from the anode dissolves into the electrolyte in the form of ions. The impurities present in the impure metal gets collected below the anode. This is known as anode mud.





**(iii) Vapour phase refining:** Vapour phase refining is the process of refining metal by converting it into its volatile compound and then, decomposing it to obtain a pure metal. To carry out this process,

- (i)** the metal should form a volatile compound with an available reagent, and
- (ii)** the volatile compound should be easily decomposable so that the metal can be easily recovered.

Nickel, zirconium, and titanium are refined using this method.