

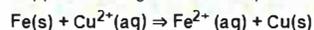
Remove Watermark Now

# NCERT SOLUTIONS CLASS-XII CHEMISTRY CHAPTER-6 PRINCIPLES OF ELEMENTS

Q1. Explain why hydro-metallurgy can extract copper, but cannot extract zinc.

Ans:

Copper has a higher reduction potential than zinc or iron. Thus, in hydro-metallurgy iron and zinc can be used to displace copper from its solution

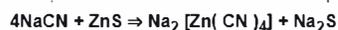


However, in-order to displace zinc a metal more reactive than it is required e.g. K, Ca, etc. The problem arising now is that all these metals react with water to liberate hydrogen gas. Thus, they cannot be used for the extraction of zinc using hydro-metallurgy.

Q2. What role does a depressant play in the process of froth floatation ?

Ans:

The role of a depressant in froth floatation is to set apart two sulphide ores through selective prevention of one ore from frothing. E.g. NaCN is used to separate two sulphide ores, PbS and ZnS. NaCN forms a complex,  $\text{Na}_2[\text{Zn}(\text{CN})_4]$ , with zinc on the surface of zinc sulphide, thus selectively preventing ZnS from frothing



Q3. Why is it more difficult to extract copper from pyrites than it is to extract copper from its oxide ore ?

Ans:

Hydrogen sulfite and carbon disulfite ( $\text{CS}_2$ ) has a larger  $\Delta_f G$  (Gibbs free energy of formation) than copper (I) sulfite. Thus, C and  $\text{H}_2\text{S}$  will not be able to reduce  $\text{Cu}_2\text{S}$  to Cu. Whereas,  $\Delta_f G$  of  $\text{Cu}_2\text{O}$  is larger than carbon monoxide's, thus C can reduce copper (I) oxide to copper.

Therefore, it is more difficult to extract copper from pyrites than it is to extract from its oxide.

Q4. Write notes on

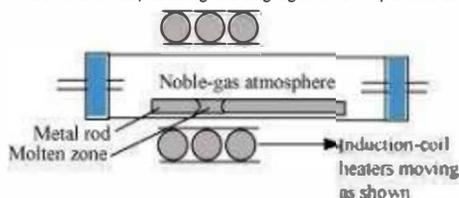
(a) Zone refining

(b) Column chromatography.

Ans:

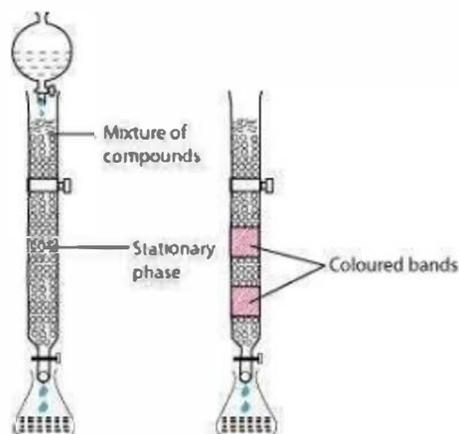
(a) Zone refining:

This method makes use of a principle according to which impurities are more soluble in molten metal than in a solid metal. In zone refining, a moving circular heater slowly moves over an impure metal rod/ bar. As the circular heater moves, the impurities move into the adjacent molten zone and the pure metal crystallizes out. This is repeated over several times, causing the segregation of impurities at one end of the bar. This impure end is then cut off. Boron, silicon, gallium etc. are purified this way.



(b) Column chromatography:

This is a very useful method of purifying elements present in minute amounts. Column chromatography is mostly used in order to take away those impurities which are not very different in chemical properties from the element which needs to be purified. This concept follows the principle various components of a mixture are adsorbed to different extents on an adsorbent.



**Chromatography includes two phases : mobile phase and stationary phase.** This phase ( stationary ) is immiscible and immobile. A column of adsorbent e.g.  $Al_2O_3$  is used as the stationary phase. The mixture to be purified is dissolved in the mobile phase which can be a liquid, gas or supercritical fluid. This is then poured onto the top of the column. The component which is more strongly adsorbed by the adsorbent takes a greater amount of time to move through it than the component that is weakly adsorbed. This way the different components of the mixture are separated as they move through the stationary phase.

Remove Watermark Now

**Q5. At 673 K which is a more effective reducing agent, CO or C ?**

**Ans:**

At 673 K, CO is a more effective reducing agent because, at 673 K the value of  $\Delta G_{(C,CO)}$  is greater than the value of  $\Delta G_{(CO,CO_2)}$ , which means that CO is more easily reduced to  $CO_2$  than C to CO.

**Q6. In the process of electrolytic refining of copper what are the common elements in the anode mud ? What is the reason for their presence ?**

**Ans:**

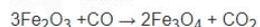
**Selenium, silver, tellurium, platinum, antimony and gold** are the common elements present in the anode mud during the electrolytic refining of copper. As these metals are almost unreactive they are not affected during the purification method. **Thus, they are present in the anode mud.**

**Q7. State the various reactions that take place inside the different zones of a blast furnace during iron extraction.**

**Ans:**

Inside a blast furnace iron oxide is reduced at different temperature ranges, as given below:

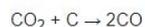
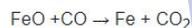
**At 500 – 800 K**



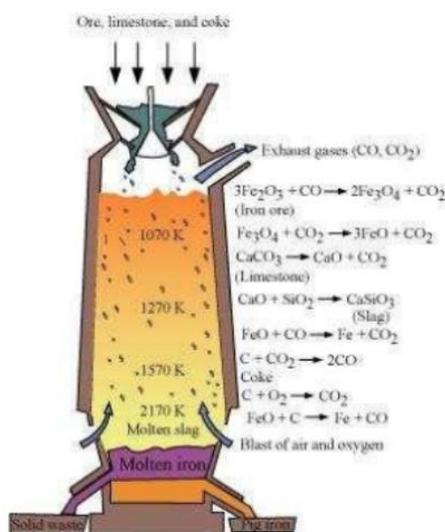
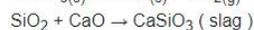
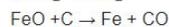
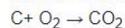
**At 850 K**



**At 900 – 1500 K**



**Above 1570 K**



**Q8. Write the chemical reactions involved in zinc extraction from zinc blend.**

**Ans:**

The various steps involved in zinc extraction are :

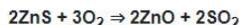
**(1) Concentration of ore**

Firstly to remove the impurities of the ore, zinc blende is crushed and concentration is done by **froth floatation**

Firstly, to remove the impurities of the ore, zinc blende is crushed and concentration is done by **floatation**.

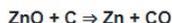
### (2) Conversion to oxide (Roasting)

In this step ZnS is roasted in excess of air in a furnace at a temperature below the melting point of zinc. This results in the formation of zinc oxide.



### (3) Extraction of Zn from ZnO (Reduction):

To extract zinc from zinc oxide it is mixed with powdered coke and then heated.



### (4) Electrolytic Refining:

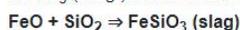
In this method, impure zinc becomes the anode while the cathode is a pure copper strip. The electrolyte is an acidic solution of zinc sulphate ( $\text{ZnSO}_4$ ) with dilute sulfuric acid.

On passing a current, **pure zinc deposits on the copper strip**.

## Q9. What role does silica play in copper metallurgy ?

Ans:

Copper pyrites are converted to a mixture of  $\text{Cu}_2\text{O}$  and  $\text{FeO}$  during roasting. Acidic silica is added during smelting to separate the  $\text{FeO}$  from the mixture.  $\text{SiO}_2$  and  $\text{FeO}$  forms  $\text{FeSiO}_3$  (slag) which floats on the molten matter.



## Q10. "Chromatography", What do you understand by this term?

Ans:

**Chromatography** is a collective term used for a range of laboratory techniques for the purification, separation, characterization and identification of the species of a mixture whether colored or colorless. The word has been obtained from two Greek words; 'graphy' meaning 'to write' and 'chroma' meaning 'colour'. **There are numerous chromatographic techniques like column chromatography, paper chromatography, gas chromatography, etc.**

## Q11. What is the criterion followed while selecting the stationary phase of chromatography ?

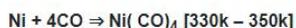
Ans:

The choice of stationary phase is done in a way that the elements of the mixture have different solubility in the phase. Thereby, different elements have different movement speed through the phase, because of which they can be **separated from each other**.

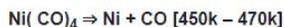
## Q12. Write about a technique used to refine nickel ?

Ans:

Mond's process is technique used to refine nickel. In this method, heat is supplied to nickel in the presence of carbon monoxide to produce nickel tetracarbonyl, which is a volatile complex.



The **nickel tetracarbonyl** so obtained is then decomposed by heating it at a higher temperature (450 – 470 K) to form pure nickel.

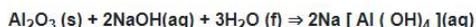


## Q13. How is alumina separated from silica in a bauxite ore associated with silica? Provide equations, if present.

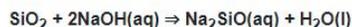
Ans:

Separation of alumina from silica in a bauxite ore associated with silica is as follows :

Firstly, concentrated  $\text{NaOH}$  solution is used to digest the powdered ore at 473 – 523 K and at a pressure of 35 – 36 bar. This causes alumina ( $\text{Al}_2\text{O}_3$ ) and silica ( $\text{SiO}_2$ ) to leach as sodium aluminate and sodium silicate respectively, abandoning the impurities behind.



**Alumina sodium aluminate**



**Silica Sodium silicate**

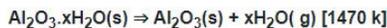
Now, to neutralize the aluminate present in the solution, carbon dioxide gas is passed through the solution we obtained. This causes the sodium meta – aluminate to precipitate as hydrated alumina.



**hydrated alumina**

Sodium silicate cannot be precipitated as it is filtered off. The hydrated alumina is dried, heated and filtered to obtain pure alumina.

Sodium silicate cannot be precipitated so it is filtered off. The hydrated alumina is dried, heated and filtered to obtain pure alumina.



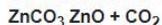
Remove Watermark Now

**Q14. Differentiate between 'calcination' and 'roasting' with the help of examples.**

**Ans:**

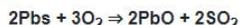
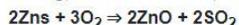
**Calcination** is the conversion of carbonate and hydroxide ores to oxides by heating them at a temperature below their melting points and in the absence or in a very limited supply of air.

For example, carbonates of Ca, Mg, Zn are turned into their respective oxides through this process.



**Roasting** is the conversion of sulfide ores into their metallic oxides by heating at a temperature below their melting points in excess presence of air.

For e.g, sulfide ores of Pb, and Zn are turned into their respective oxides through this process.



**Q15. What is the difference between 'cast iron' and 'pig iron' ?**

**Ans:**

Pig iron is the iron obtained from blast furnace. It is 4% carbon and contains many other impurities like Si, P, S, Mn in lesser amounts.

Cast iron is made by melting pig iron and coke with the help of a hot air blast. It has lower levels of carbon in it (3%). **Unlike pig iron, cast iron is brittle and extremely hard.**

**Q16. What is the difference between "ores" and "minerals" ?**

**Ans:**

Minerals are naturally available substances having metals or their compounds.

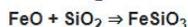
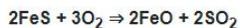
Ores are rocks and minerals from which metals are economically and conveniently obtained.

For e.g., there are a lot of minerals that contain, but zinc cannot be conveniently and economically extracted from all of them. Zinc is extracted from calamine ( $\text{ZnCO}_3$ ), zinc blende ( $\text{ZnS}$ ), etc. **Hence, these minerals qualify as ores of zinc.**

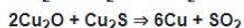
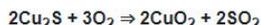
**Q17. Why is copper matte put in converters lined with silica ?**

**Ans:**

Copper matte has  $\text{Cu}_2\text{S}$  and some  $\text{FeS}$ . So, when a hot blast of air is blown through a molten matte placed in a silica lined converter,  $\text{FeS}$  of the matte oxidizes to  $\text{FeO}$ . This  $\text{FeO}$  combines with  $\text{SiO}_2$  (silica) to produce  $\text{FeSiO}_3$  (slag).



When all of the iron has been removed as slag  $\text{Cu}_2\text{S}$  is oxidized to  $\text{Cu}_2\text{O}$  which then undergoes a reaction with  $\text{Cu}_2\text{S}$  to give copper metal.



**Q18. In the metallurgy of aluminium, what role does Cryolite play ?**

**Ans:**

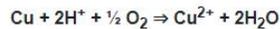
$\text{Na}_3\text{AlF}_6$  (Cryolite) has two basic roles:

1. The melting point of the solution is decreased from 2323 to 1140 K due to the presence of cryolite.
2. Cryolite makes alumina a good conductor of electricity.

**Q19. How is leaching done in when dealing with low grade copper ores?**

**Ans:**

When dealing with low grade copper ores, bacteria or acids are used in the presence of air to leach the copper. In this method, copper enters the solution as  $\text{Cu}^{2+}$  ions :



The solution so obtained is then treated with H<sub>2</sub> or scrap iron to get copper metal.



Q20. Why isn't zinc oxide reduction (using carbon monoxide) used to extract zinc ?

Ans:

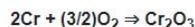
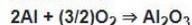
As the standard Gibbs free energy of formation of CO to CO<sub>2</sub> is higher than that of Zn to ZnO, CO will not be able to reduce ZnO to Zn. **Therefore, zinc oxide reduction using CO isn't used to extract zinc.**

Q21. Δ<sub>f</sub>G<sup>θ</sup> has a value of - 540 kJ mol<sup>-1</sup> for Cr<sub>2</sub>O<sub>3</sub> formation and - 827 kJ mol<sup>-1</sup> for Al<sub>2</sub>O<sub>3</sub> formation .Can Cr<sub>2</sub>O<sub>3</sub> be reduced by Al ?

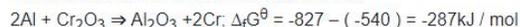
Ans:

As Cr<sub>2</sub>O<sub>3</sub> has a higher value of formation ( -540 kJ mol<sup>-1</sup> ) than Al<sub>2</sub>O<sub>3</sub> ( -827 kJ /mol ), Al can thus reduce Cr<sub>2</sub>O<sub>3</sub> to Cr.

Alternatively,



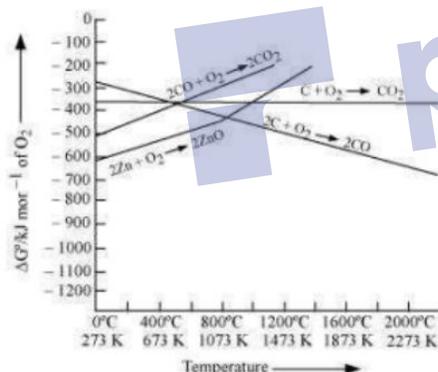
Subtracting equation (ii) from (i) , we have



As Δ<sub>f</sub>G<sup>θ</sup> is negative for the reduction reaction of Cr<sub>2</sub>O<sub>3</sub> by Al , the reaction can take place.

Q22. Which one is better at reducing ZnO, C or CO<sub>2</sub> ?

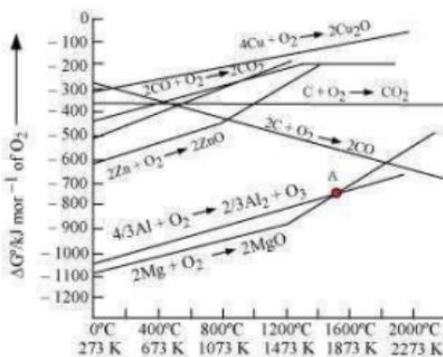
Ans:



ZnO is reduced to Zn at around 1673 K. From the figure below, we can observe that beyond 1073 K the Gibbs free energy of formation of CO from C and beyond 1273 K, the Gibbs free energy of formation of CO<sub>2</sub> from C is smaller than the Gibbs free energy of formation of ZnO. Thus, C can reduce ZnO to Zn. However, the Gibbs free energy of formation of CO<sub>2</sub> from CO is greater than the Gibbs free energy of formation of ZnO. **Thus, CO is not able to reduce ZnO making C a better reducing agent for ZnO.**

Q23. In some particular case thermodynamic factor dictates the choice of the reducing agent. To what extent do you believe this statement to be true ? Provide two examples to back your opinion.

Ans:



The figure given below is a graph of Gibbs energy  $\Delta_f G^\ominus$  vs Temperature for the formation of solid oxides. We can see from this graph that if  $\Delta_f G^\ominus$  of a metal's oxide is more negative than another metal's oxide, then the former metal can reduce the oxide of the latter metal ( i.e., the oxide with less negative  $\Delta_f G^\ominus$  ). For example,  $\Delta_f G^\ominus$  ( Al,  $\text{Al}_2\text{O}_3$  ) is more negative than  $\Delta_f G^\ominus$  ( Cu,  $\text{Cu}_2\text{O}$  ), thus Al can readily reduce  $\text{Cu}_2\text{O}$  to Cu but it is not possible for Cu to reduce  $\text{Al}_2\text{O}_3$ . Likewise, **it isn't possible for Zn to reduce MgO but Mg can reduce ZnO to Zn. This is because  $\Delta_f G^\ominus$  ( Mg, MgO ) is more negative than  $\Delta_f G^\ominus$  ( Zn, ZnO ).**

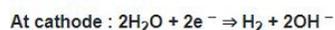
**Q24. What are the processes that give chlorine as a by-product ? What happens when an aqueous of NaCl is electrolyzed ?**

**Ans:**

In Down process, chlorine is obtained as a byproduct. In this process fused mixture of  $\text{CaCl}_2$  and NaCl is electrolyzed at 873 K. Sodium is obtained the cathode and  $\text{Cl}_2$  is discharged at the anode.

When an aqueous solution of NaCl is subjected to electrolysis,  $\text{Cl}_2$  is discharged at the

anode. At the cathode,  $\text{H}_2$  is obtained ( in place of Na ). This is because the standard reduction potential of  $\text{H}_2\text{O}$  ( $E^\ominus = -0.83 \text{ V}$ ) is less negative than that of Na ( $E^\ominus = -2.71 \text{ V}$ ). Thus,  $\text{H}_2\text{O}$  will get a higher preference to get reduced at the cathode thereby discharging  $\text{H}_2$ .



**Q25. What role does a graphite rod play in the electrometallurgy of aluminium?**

**Ans:**

In the **electrometallurgy of aluminium**, the anode is graphite and the cathode iron is graphite lined. The  $\text{O}_2$  being liberated due to electrolysis reacts with the graphite anode to liberate  $\text{CO}_2$  and CO. Had it been any other metal besides graphite, the oxygen would have reacted with the aluminium during the electrolysis to form  $\text{Al}_2\text{O}_3$ . This would have resulted in the wastage of aluminium and as graphite is cheaper than aluminium it is expendable.

**This is the role of aluminum.**

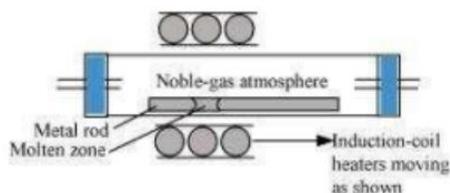
**Q26. What are the principles of refining a metal by the following processes :**

- (a) Zone refining
- (b) Electrolytic refining
- (c) Vapour phase refining

**Ans:**

**(a) Zone refining :**

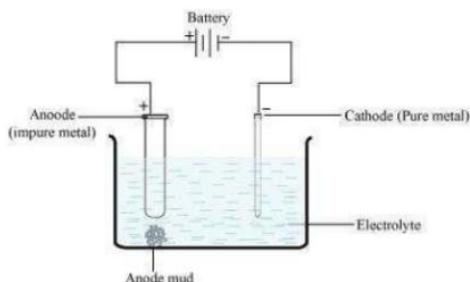
This method makes use of a principle according to which impurities are more soluble in molten metal than in a solid metal. In zone refining, a moving circular heater slowly moves over an impure metal rod/ bar. As the circular heater moves, the impurities move into the adjacent molten zone and the pure metal crystallizes out. This is repeated over several times, causing the segregation of impurities at one end of the bar. This impure end is then cut off. Boron, silicon, gallium etc. are purified this way.



**(b) Electrolytic refining :**

It is the refining of impure metals using electricity. In this method, the anode is the impure metal and the cathode is a thin sheet of pure metal. The electrolyte is a salt solution of the same metal.

On passing the electric current the metal ions from the electrolyte collect at the cathode as pure metal and the impure metal of the anode dissolves into the solution ( electrolyte ) in the form of ions. The impurities of the metal deposits below the anode. This is called the anode mud.



**(c) Vapour phase refining :**

It is a method of metal refining by converting the metal into its volatile compound and then decomposing it to get the pure metal.

**To achieve this:**

(1) the metal should convert into a volatile compound with a reagent,

(2) the volatile compound of the metal has to be able to decompose easily so that the pure metal can be conveniently recovered.

**Zirconium, titanium and nickel are refined through this method.**

Remove Watermark Now

**Q27. Under what conditions could Al reduce MgO ?**

**Ans:**

The standard Gibbs free energy of formation of  $\text{Al}_2\text{O}_3$  from Al is smaller than that of MgO from Mg after  $1350^\circ\text{C}$ . **Thus, at a temperature beyond  $1350^\circ\text{C}$ , Al can reduce MgO.**

 pdfelement

