Chemistry Worksheets Class 12 on Chapter 6 General Principles and Processes of Isolation of Elements with Answers - Set 1

Q1. Common impurities present in bauxite are-

a.) CuO
b.) ZnO
c.)Fe_2O_3
d.) SiO_2

Correct Answer– (c.)Fe_2O_3 and (d.) SiO_2

Q2. Which of the following is not an ore of magnesium?

a.) Gypsum
b.) Dolomite
c.) Magnesite
d.) Carnallite

Correct Answer– (a.) Gypsum

Q3. The metal which is always found in the free state is-

a.) Gold
b.) Silver
c.) Copper
d.) Sodium

Correct Answer– (a.) Gold

Q4. Roasting results in the production of metal in the case of–

a.) Iron pyrite
b.) Cinnabar
c.) Galena
d.) Bauxite

Correct Answer– (b.) Cinnabar

Q5. Zone refining has been employed for preparing ultra-pure samples of–

a.) Cu
b.) Na
c.) Ge
d.) Zn

Correct Answer– (c.) Ge

Q6. What is gangue?

Answer. A gangue can be defined as an unwanted material or impurities in the form of sand, rock or any other material that surrounds the mineral in an ore deposit. This substance is common when it comes to the aspect of mining. Usually, gangue has to be separated from mineral and the process used is known as mineral dressing, mineral processing or ore dressing.

Q7. Define metallurgy.

Answer. The process of extracting metals from their ores is called metallurgy. The ores mined from the earth's crust are never pure. The process of metallurgy depends upon the nature of the ore and the impurities present in it. The common steps involved in metallurgical operations are:
(i.) Crushing and grinding of the ore.
(ii.) Concentration or benefaction of the ore.
(iii.) Extraction of crude metal from the concentrated ore.
(iv.) Purification or refining of the metal.

Q8. Why do metal sulphides occur mainly in rocks and metal halides occur mostly in lakes and seas?

Answer. Metal sulphides are insoluble in water and therefore, they occur mostly in rocks. On the other hand, metal halides are highly soluble in water. Therefore, they get dissolved in rain water and are carried to lakes and seas.

Q9. What are the major steps of extraction and isolation of metals?

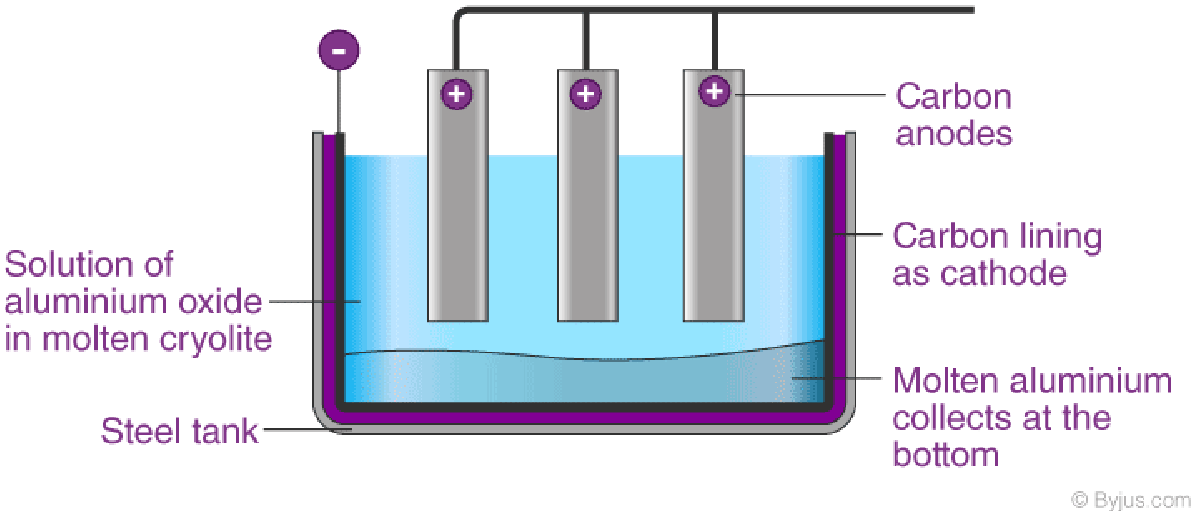
Answer. The extraction of metals and their isolation occurs over a few major steps:

- Concentration of Ore.
- Isolation of metal from concentrated Ore.
- Purification of the metal.

Q10. What do you understand by Hall–Heroult process?

Answer. The Hall-Heroult process is widely used in the extraction of aluminium. In the Hall-Heroults process, pure Al_2O_3 is mixed with CaF_2 or Na_3AlF_6. This results in a lowering of the melting point of the mixture and increases its ability to conduct electricity. A steel vessel with a lining of carbon and graphite rods is used.

The carbon lining acts as a cathode and graphite act as an anode. When electricity is passed through the electrolytic cell which consists of carbon electrodes oxygen is formed at the anode. This oxygen formed reacts with the carbon of the anode to form carbon monoxide and carbon dioxide. In this method of production of aluminium for every 1 kg of Al produced, approximately 0.5 Kg of carbon anode is burnt.



Aluminium ions are created at the adverse cathode from the aluminium oxide and then sink down because they are heavier than the cryolite solution. Then, the liquid shape of the aluminium that has sunk to the bottom. On the other side, at the positive anode, the oxygen from the aluminium oxide forms and responds to carbon dioxide CO_2 with the graphite carbon.

Q11. Name two examples of the following ores:
a.) Oxides
b.) Sulphides
c.) Carbonates
d.) Silicates

Answer. a.) Oxides – Haematite Fe_2O_3, Bauxite $Al_2O_3.2H_2O$
b.) Sulphides – Copper glance Cu_2S, Zinc blende ZnS
c.) Carbonates – Siderite $FeCO_3$, Dolomite $CaCO_3.MgSO_4$
d.) Silicates – Willemite Zn_2SiO_4, Feldspar $KAlSi_3O_8$

Q12. Differentiate between Roasting and Calcination.

Answer. the major differences between calcination and roasting.

Calcination	Roasting

Calcination is a process in which ore is heated in the absence of air or air might be supplied in limited quantity	Roasting involves heating of ore lower than its melting point in the presence of air or oxygen.
Calcination involves thermal decomposition of carbonate ores.	Roasting is carried out mostly for sulfide minerals.
During calcination, moisture is driven out from an ore.	Roasting does not involve dehydrating an ore.
Carbon dioxide is given out during calcination	During roasting large amount of toxic, metallic and acidic compounds are released.

Q13. Why is the reduction of a metal oxide easier if the metal is formed in the liquid state at the temperature of reduction?

Answer. The entropy of metal is higher in its liquid state than its solid-state. Therefore, entropy change ΔS of the reduction process is more on the positive side when the metal formed is in a liquid state and metal oxide being reduced is in the solid-state. Since the value of $T\Delta S$ increases and that of ΔH remains constant, therefore, the value of ΔG becomes more on the negative side and therefore, the reaction becomes easier.

Q14. The value of $\Delta_f G°$ for the formation of Cr_2O_3 is –540 kJ mol^{-1} and that of Al_2O_3 is –827 kJ mol^{-1}. Is the reduction of Cr_2O_3 possible with Al?

Answer. The two equations are:

(i) $\frac{4}{3}Al + O_2 \rightarrow \frac{2}{3}Al_2O_3$

$\Delta_f G°$ (Al, Al_2O_3) = –827 kJ mol^{-1}

(ii) $\frac{4}{3}Cr + O_2 \rightarrow \frac{2}{3}Cr_2O_3$

$\Delta_f G°$ (Cr, Cr_2O_3) = –540 kJ mol^{-1}

Subtracting eq. (ii) from eq. (i), we get

$$\frac{4}{3}Cr + \frac{2}{3}Cr_2O_3 \rightarrow \frac{2}{3}Al_2O_3 + \frac{4}{3}Cr$$

$\Delta_f G°$= –287 kJ mol^{-1}.

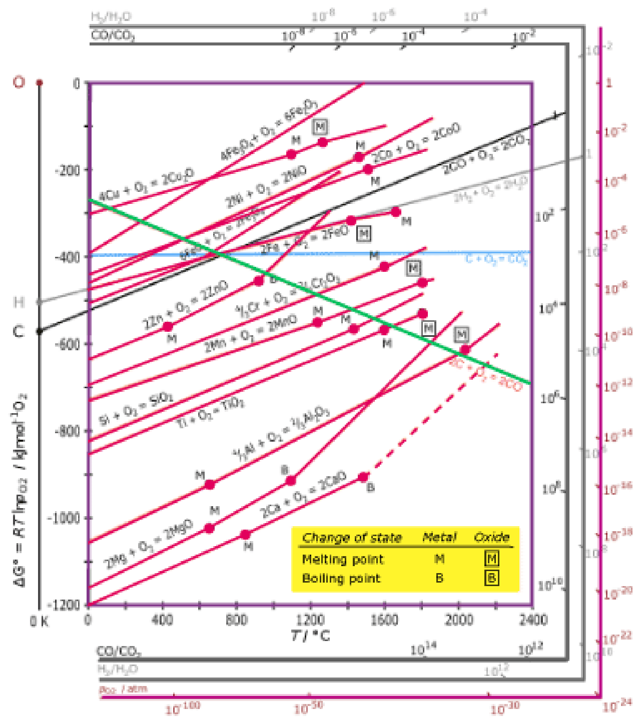
Since, $\Delta_f G°$ for the combined reaction is –ve, therefore, the reduction of Cr_2O_3 by Al is possible.

Q15. Write down the reactions taking place in different zones in the blast furnace during the extraction of iron.

Answer. In the blast furnace, the reduction of iron oxides takes place in different temperature ranges. The lower part of the blast furnace has a high temperature of the order of 2200 K (called combustion zone) and the top of the furnace has a low temperature of the order of 500-800 K (called reduction zone). The reduction occurring in the lower temperature range (upper part) is by carbon and in the higher temperature range (lower part) is by carbon monoxide.
At a lower temperature range (500–800K) in the upper part of the furnace, the reactions occurring are:
$3Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$
$Fe_3O_4 + 4CO \rightarrow 3Fe + 4CO_2$
$Fe_2O_3 + CO \rightarrow 2Fe_3 + CO_2$
The reactions taking place in the higher temperature range (900 - 1500 K) in the blast furnace are:
$C + CO_2 \rightarrow 2CO$
$FeO + CO \rightarrow Fe + CO_2$
The silicate impurity of the ore is removed as slag by calcium oxide (CaO), which is formed by the decomposition of limestone ($CaCO_3$).
$CaCO_3 \rightarrow CaO + CO_2$
$CaO + SiO_2 \rightarrow CaSiO_3$

Q16. Explain the Ellingham diagram?

Answer.



1. Ellingham diagram is a plot between $\Delta_f G°$ and T for the formation of oxides of metals. A general reaction expressing oxidation is given by:
   $2xM(s) + O_2(g) \rightarrow 2MxO(s)$
2. As is evident from the reaction, the gaseous amount of reactant is decreasing from left to right as the product formed is solid metal oxide on the right side. Hence, we can say that molecular randomness is also decreasing from left to right. Thus, ΔS is negative and ΔG shifts towards the higher side despite rising T. Hence, for most of the reactions shown above for the formation of MxO (s), the curve is positive.
3. Except for the processes in which change of phase takes place, each plot is a straight line. This temperature at which change of phase takes place is indicated by a positive increase in the slope. For example, the melting is indicated by an abrupt change in the curve in Zn, ZnO plot.
4. The metal oxide (MxO) is stable at the point in a curve below which ΔG is negative. Above this point, the metal oxide is unstable and decomposes on its own.
5. Feasibility of reductions of the oxide of the upper line by the element represented by the lower line is determined by the difference in the two $\Delta_r G°$ values after the point of intersection in the Ellingham diagram.

Q17. Explain the electrochemical principle of metallurgy?

Answer. The electrochemical principles of metallurgy are as follows:
1. The reduction of metal ions to their respective metals in solution or molten states is the most important step in this type of metallurgy.

2. Electrolytic reduction is accomplished through the use of reducing elements. As shown in the chemical equation, metal ion and reducing element produce metal and reduced ion.
$M^{n+} + A \rightarrow M + A^{n+}$
3. The following equation explains these electrochemical principles:
$\Delta G° = -nE°F$
Where n denotes the number of electrons gained.
E = Redox Reaction Standard Electrode Potential
4. A metal's reactivity is determined by the value of E. Metals with a high E are more reactive, while metals with a low E are less reactive.
5. It can be difficult to reduce metals with higher negative E values.
6. If the difference between the E values of two metals is positive, the value of G will be negative.
7. As a result, the less reactive metal will exit the solution and the more reactive metal will enter the solution. Cu(II) is reduced to Cu in the presence of iron, for example.
$Cu^{n+} + Fe \rightarrow Cu + Fe^{n+}$

Q18. Explain the significance of the leaching in the extraction of aluminium?

Answer. Bauxite is the primary ore of aluminium. It typically contains silica (SiO_2). Impurities include iron oxide (Fe_2O_3) and titanium oxide (TiO_2). These impurities can be removed through the leaching process. At 473 – 523K, the powdered bauxite ore is heated with a concentrated (45 %) solution of NaOH, where alumina dissolves as sodium metal aluminate and silica (SiO_2) dissolves as sodium silicate, leaving Fe_2O_3, TiO_2, and other impurities behind.

$$Al_2O_3 + 2NaOH + 3H_2O \xrightarrow{473-523K} 2Na\left[Al\left(OH\right)_4\right]$$

$$SiO_2 + 2NaOH \xrightarrow{473-523K} NaSiO_3 + H_2O$$

Impurities are filtered out, and the sodium meta aluminate solution is neutralised by passing CO_2 when hydrated alumina separates and sodium silicate remains in the solution.
$2Na[Al(OH)_4]_{aq} + 2CO_2 \rightarrow Al_2O_3.xH_2O + 2NaHCO_3$

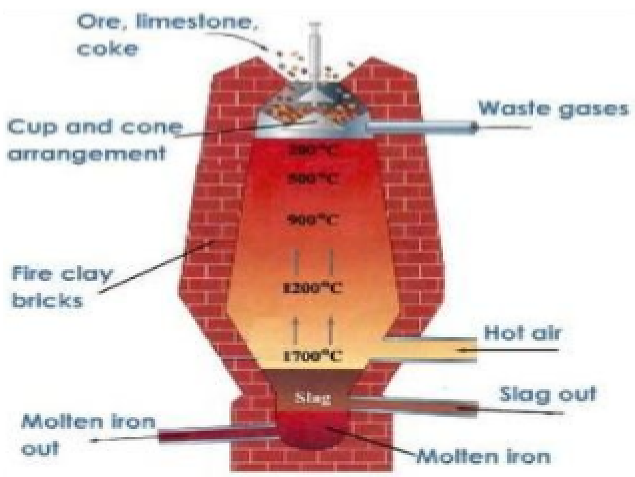
The hydrated alumina obtained is then filtered, dried, and heated to produce pure alumina.
$Al_2O_3.xH_2O \rightarrow Al_2O_3 + xH_2O$

Thus, the importance of leaching in aluminium extraction is to prepare pure alumina from bauxite ore.

Q19. Give the extraction process of iron.

Answer. The extraction of iron from its ore is a long and subdued process, that helps in separating the useful components from the waste materials such as slag. It is done in a blast furnace.
The Blast Furnace reduces the concentrated ore chemically to its liquid metal state. A blast furnace is a gigantic, steel stack lined with refractory brick where the concentrated iron ore, coke, and limestone are dumped from the top, and a blast of hot air is blown into the bottom. All three ingredients are crushed into small round pieces and mixed and put on a hopper which controls the input.

Hot air is blown from the bottom and coke it burned to yield temperatures up to about 2200K. Burning coke provides the majority of the heat required for this process. At such high temperatures, Coke reacts with the oxygen in the hot air to form Carbon Monoxide (CO). The CO and heat now move upwards and meet the raw material running down from the top. The temperature in the upper parts of the Blast Furnace is considerably lower than the 2200K at the bottom. In this part, Haematite (Fe_2O_3) and Magnetite (Fe_3O_4) are reduced to Ferrous Oxide (FeO).



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The iron manufactured in Blast Furnaces contain about 3 – 4 % of Carbon and smaller quantities of many other impurities such as sulphur, Silicon, etc. This is called Pig Iron. It is a hard but brittle metal and the impurities severely hamper its strength. Carbon seems to play a significant role in influencing the brittleness and hardness balance in iron. To further reduce the carbon content of pig iron, it is melted again with scraps of iron and coke and subjected to the blast of hot air. This kind of iron is called Cast Iron and has a slightly lower carbon content 2 – 3 %. This is even harder than pig iron.

Q20. Give uses of aluminium, copper, zinc and iron.

Answer. Uses of Aluminium

- Aluminium is used for making electrical transmission cables as it is a good conductor of electricity.
- Aluminium powder is used as a reducing agent in thermite welding.
- It is used in anti-rust paint and lacquers.
- It is used to remove dissolved oxygen during the extraction of certain metals.
- It is also used in making certain alloys which are extensively used for household purposes.

Uses of Copper

- Copper is used for making electric wires.
- It is used in electroplating.
- It is used in several alloys which are tougher than the metal itself. The common alloys are brass, bronze, gunmetal, coinage metal, etc.
- It is also used for alloying with gold and silver to make them hard for the purpose of making ornaments and coins

Uses of Zinc

- Zinc is widely used for galvanising iron.
- It is used in the extraction of gold and silver by the cyanide process.
- Zinc dust is used as a reducing agent in the laboratory. It is also used in the manufacture of drugs, dye stuffs paints and other chemicals, etc.
- Zinc is used in dry cells as electrodes.
- It is used in the manufacture of many alloys such as brass, german silver, etc.

Uses of Iron

- Cast iron which is the most important form of iron is used for casting stoves, railway sleepers, gutter pipes, toys, etc.
- It is used in th manufacture of wrought iron and steel.