Chemistry Worksheets Class 12 on Chapter 6 General Principles and Processes of Isolation of Elements with Answers - Set 4

Q1. The first step in the extraction of copper from copper pyrites is-

a.) reduction by carbon.
b.) electrolysis of ore
c.) roasting of ore in O_2
d.) magnetic separation

Correct Answer– (c.) roasting of ore in O_2

Q2. The common impurity present in bauxite is-

a.) CuO
b.) ZnO
c.) Fe_2O_3
d.) Cr_2O_3

Correct Answer– (c.) Fe_2O_3

Q3. Which of the following ore is best concentrated by froth floatation method?

a.) Magnetite
b.) Siderite
c.) Galena
d.) Malachite

Correct Answer– (c.) Galena

Q4. Which of the following is a mineral of iron?

a.) Malachite
b.) Cassiterite
c.) Pyrolusite
d.) Magnetite

Correct Answer– (d.) Magnetite

Q5. Which of the following ore is concentrated by chemical leaching method?

a.) Argentite
b.) Galena
c.) Copper glance
d.) Cinnabar

Correct Answer– (a.) Argentite

Q6. What is gravity separation?

Answer. This method is based on the differences in the specific gravities of metallic ore and the gangue particles. Therefore, this method is known as gravity separation. This process is frequently used when lighter earthly particles are removed from heavier ore particles by washing them with water. For example, this method is commonly used for oxide ores such as haematite, tin stone and native ore of Au, Ag, etc.

Q7. What is cupellation?

Answer. Cupellation is a method used for refining of those metals which contain impurities of other metals which form volatile oxides. For example, the removal of the last traces of lead from silver.

Q8. Why is the froth floatation method selected for the concentration of sulphide ores?

Answer. Froth flotation is a method of selectively separating hydrophobic from hydrophilic materials. The froth flotation process works on the principle that sulphide ores are preferentially wetted by pine oil, whereas gangue particles are wetted by water.

Q9. At a site, low-grade copper ores are available and zinc and iron scraps are also available. Which of the two scraps would be more suitable for reducing the leached copper ore and why?

Answer. Since zinc lies above iron in the electrochemical series, it is more reactive than iron. As a result, if zinc scraps are used the reduction will be fast. However, zinc is costlier than iron. Therefore, it will be advisable and advantageous to use iron scraps.

Q10. (i) How is chemical reduction different from electrolytic reduction?
(ii) Name a metal each is obtained by–
(a) Electrolytic reduction
(b) Chemical reduction

Answer. (i) In chemical reduction, the reduction of any compound is done with the help of a chemical substance, without the application of any external agents, such as current. Whereas in electrolytic reduction, the reduction process is done by creating the potential difference between the two electrodes, with the help of electrolytes and current.

Also, in chemical reduction, the reduction of any compounds is due to the movement of atoms, whereas in electrolytic reduction, the reduction is due to the movement of electrons.

(ii) (a) Sodium is a highly reactive metal and it cannot be reduced by carbon or aluminium. Thus, it is reduced by electrolysis.
(b) Zinc oxide is reduced to metallic zinc by heating with carbon.

Q11. Differentiate between "minerals" and "ores".

Answer. Minerals are naturally occurring chemical substances in the earth's crust obtainable by mining. The minerals from which a metal can be economically and conveniently extracted is ore.
For example, Al occurs in the earth's crust in the form of two chemical substances bauxite $Al_2O_3.2H_2O$ and clay $Al_2O_3.2SiO_2.2H_2O$. These are called minerals.
However, Al can be conveniently and economically extracted from bauxite. Therefore, bauxite is an ore of Al.

Q12. Why is it advantageous to roast a sulphide ore to the oxide before reduction?

Answer. The standard free energy of formation of most of the sulphide ores are larger than those of CS_2 and H_2S. Therefore, these sulphides are most stable than those with carbon or hydrogen. Hence, neither carbon nor hydrogen can reduce metal sulphides to metal. In contrast, the standard free energies of formation of oxides are much lower than those of SO_2 and therefore oxidation of metal sulphides to metal oxides is thermodynamically favourable. Therefore, it is a common practice to roast sulphide ore to oxide ore before reduction.

Q13. Thermite process is quite useful for repairing broken parts of machines. Explain.

Answer. In the thermite process, oxides of metals like iron are reduced by aluminium. This reaction is highly exothermic and a large amount of heat is evolved during the reaction. As a result of large heat, the metal will be in the molten state.
For example,
$Fe_2O_3 + 2Al \rightarrow Al_2O_3 + 2Fe + Heat$
If the molten metal is allowed to fall between the broken parts of a machine, the gaps will be filled up. Therefore, the machine will be repaired.

Q14. Why is the extraction of copper from pyrite more difficult than that from its oxide through reduction?

Answer. The standard free energy of formation ($\Delta_f G°$) of Cu_2S is lesser than those of CS_2 and H_2S. So, Cu_2S (pyrites) can not be reduced by carbon or hydrogen.
$2Cu_2S + C \rightarrow 4Cu + CS_2$
$2Cu_2S + H_2 \rightarrow 2Cu + H_2S$
However, the $\Delta_f G°$ of copper oxide is greater than that of CO_2.

Therefore, the sulphide ore is first converted to the oxide by roasting and then reduced.
Roasting: $2Cu_2S + 3O_2 \rightarrow 2Cu_2O + SO_2$
Heating: $2Cu_2O + C \rightarrow 4Cu + CO_2$

Q15. How can you separate alumina from bauxite ore associated with silica? Give equations.

Answer. To separate alumina from silica in bauxite ore that contains silica, the powdered ore is first digested with a concentrated NaOH solution at 473 - 523 K and 35 - 36 bar pressure. This causes alumina (Al_2O_3) to leach out as sodium aluminate and silica (SiO_2) to leach out as sodium silicate, leaving the impurities behind.
$Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2Na[Al(OH)_4]$
$SiO_2 + 2NaOH \rightarrow Na_2SiO + H_2O$

The resulting solution is then passed through CO_2 gas to neutralise the aluminate in the solution, resulting in the precipitation of hydrated alumina. The solution is seeded with freshly prepared samples of hydrated alumina to induce precipitation.
$2Na[Al(OH)_4] + CO_2 \rightarrow Al_2O_3.xH_2O + 2NaHCO_3$

Sodium silicate remains in the solution during this process. To obtain pure alumina, the obtained hydrated alumina is filtered, dried, and heated.
$Al_2O_3.xH_2O \rightarrow Al_2O_3 + xH_2O$

Q16. Explain the following:-
(i) Zinc but not copper is used for recovery of Ag from the complex $[Ag(CN)_2]^-$.
(ii) Partial roasting of sulphide ore is done in the metallurgy of copper.
(iii) Extraction of Cu from pyrites is difficult than that from its oxide ore through reduction.

Answer.
(i) Zn is a more potent reducing agent than copper. Zn is also less expensive than Cu.
(ii) Some oxide is formed during partial roasting of sulphide ore. This oxide then reacts with the remaining sulphide ore to produce copper, a process known as self-reduction.
$2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$,
$2Cu_2O + 2Cu_2S \rightarrow 6Cu + SO_2$.
(iii) While carbon is an excellent reducing agent for oxides, it is a poor reducing agent for sulphides. The reduction of metal sulphide has a low negative value.

Q17. Explain the extraction of zinc.

Answer. Zinc blende is the most important zinc ore. The following steps are involved in the extraction of zinc from zinc blende.
Concentration: The ore is crushed and then concentrated using the froth-floatation process.
Roasting: The concentrated ore is then roasted in the presence of excess air at around 1200 k:
$$2ZnS + 3O_2 \xrightarrow{\Delta} 2ZnO + 2SO_2$$

Reduction: Zinc oxide is mixed with powdered coke and heated to 1673 k in a fire clay retort, where it is reduced to zinc metal.

$$ZnO + C \xrightarrow{1673K} Zn + CO$$

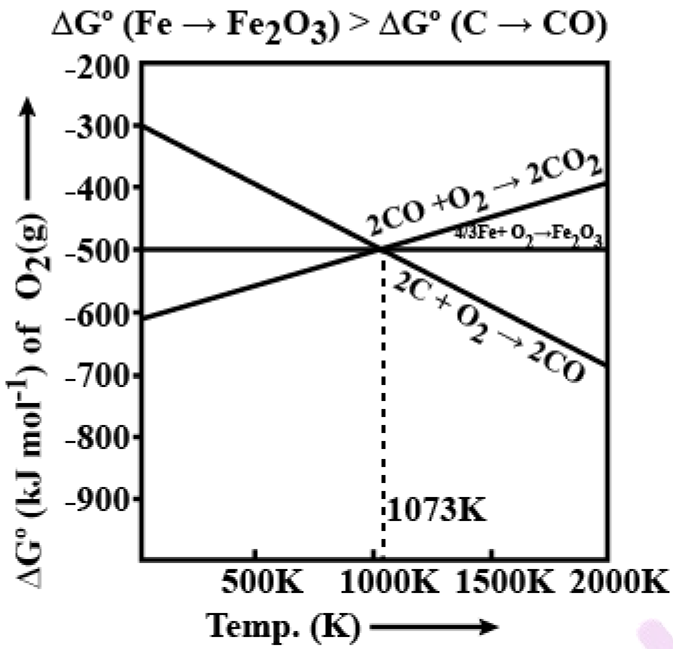
Purification: Electrolytic refining is used to purify zinc. The anode in this process is impure zinc, and the cathode is a pure thin sheet of zinc. The electrolyte is a $ZnSO_4$ solution with a trace of dil.H_2SO_4. When an electric current passes through the cathode, pure zinc is deposited.

Q18. Explain the following:
(a) Although thermodynamically feasible, in practice, magnesium metal is not used for the reduction of alumina in the metallurgy of aluminium. Why?
(b) Why is zinc and not copper used for the recovery of silver from the complex $[Ag(CN)_2]^-$?
(c) The extraction of Au by leaching with NaCN involves both oxidation and reduction. Justify giving equations.
(d) Limestone is used in the manufacture of pig iron from haematite. Why?

Answer.
(a) Magnesium is costly and not easily available in free form. So, it is not used for the reduction of alumina in the metallurgy.
(b) Copper has less reduction potential than zinc. As a result, zinc rather than copper is used to recover metallic silver from the complex $[Ag(CN)_2]^-$.
(c) The complex's gold is recovered by treating it with a more electropositive metal, such as zinc. Zinc reduces Au^+ to Au while oxidising to Zn^{2+}, which then combines with CN^- ions to form the sodium tetracyanozincate (II) complex.
As a result, the extraction of Au via NaCN leaching involves both oxidation and reduction.
(d) The flux, CaO, is provided by limestone, which combines with the impurity, SiO_2, to form easily fusible $CaSiO_3$ slag. As a result, it helps in the removal of impurity silica, SiO_2.

Q19. In the blast furnace, the reduction of Fe_2O_3 by coke (C) and carbon monoxide (CO) takes place arond 1073 K. With the help of Ellingham diiagram explain which reducing agent converts Fe_2O_3 to Fe below and above 1073 K?

Answer.



Ellingham Diagram for Reduction of Haematite by carbon

Using Ellingham diagram, we observe that at temperature greater than 1073 K, $\Delta G_{(C,\ CO)} < \Delta G_{(Fe,\ FeO)}$.

We know that according to Ellingham diagram, compound having lower $\Delta_f G$ undergoes its formation. Hence, coke can reduce FeO to Fe.

Below 1073 K CO can reduce FeO to Fe. This is because CO can be more easily oxidise to CO_2 than C to CO_2.

Q20. (i) Name the method of refining of metals such as Germanium.

(ii) In the extraction of Al, impure Al_2O_3 is dissolved in conc. NaOH to form sodium aluminate and leaving impurities behind. What is the name of this process?

(iii) What is the role of coke in the extraction of iron from its oxides?

Answer.

(i) Zone refining method is the most suitable method for refining of Germanium.

(ii) In the extraction of aluminium, impure Al_2O_3 is dissolved in concentrated NaOH to form $NaAlO_2$. This method is known as Leaching of Alumina or Bayer's process.

(iii) Coke converts iron oxide into molten iron metal. In addition, coke, when burned in the blast furnace, provides the heat required for the extraction of iron from its oxide.

$FeO + C \rightarrow Fe + CO$