Chemistry Worksheets Class 12 on Chapter 6 General Principles and Processes of Isolation of Elements with Answers - Set 5

Q1. A substance that acts as a collector in the froth floatation method is-

a.) Sodium xenate
b.) Sodium pyrophosphate
c.) Sodium nitroprusside
d.) Sodium ethyl xanthate

Correct Answer– (d.) Sodium ethyl xanthate

Q2. Copper is obtained during the extraction by the reduction of cuprous oxide with:

a.) Cu_2S
b.) SO_2
c.) FeS
d.) CO

Correct Answer– (a.) Cu_2S

Q3. The thermodynamic property useful to select the reducing agent is–

a.) Gibbs free energy change
b.) internal energy change
c.) Specific heat capacity
d.) All of the above

Correct Answer– (a.) Gibbs free energy change

Q4. The better reducing agent for ZnO is-

a.) CO
b.) C
c.) CO_2
d.) None of the above

Correct Answer– (b.) C

Q5. The metal that can be purified using zone refining is–

a.) Ni
b.) Zr
c.) In
d.) Fe

Correct Answer– (c.) In

Q6. Why is an external emf of more than 2.2 V required for the extraction of Cl_2 from brine?

Answer. For the reaction of extraction of Cl_2 from brine solution:
$2Cl^- + 2H_2O \rightarrow 2OH^- + H_2 + Cl_2$
The value of $\Delta G^\ominus$ is +ve (422kJ). For this value E° is
$\Delta G^\ominus = -nFE°$
Or

$$E^\circ = -\frac{\Delta G^\Theta}{nF} = -\frac{422 \times 10^3 J}{2 \times 96500} = -2.20V$$

Therefore, the extraction of Cl_2 from brine solution will require an external e.m.f. More than 2.20 V for the electrolysis process.

Q7. Wrought iron is the purest form of iron. Write a reaction used for the preparation of wrought iron from cast iron. How can the impurities of sulphur, silicon and phosphorous be removed from cast iron?

Answer. The reaction is:
$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$
Limestone is added as flux and the impurities of sulphur, silicon and phosphorous change to their oxides and pass into slag.

Q8. How do we separate two sulphide ores by the Froth floatation method? Explain with an example.

Answer. Two sulphide ores can be separated by adjusting the proportion of oil to water or by using depressants. For example, in the case of an ore containing ZnS and PbS, the depressant NaCN is used. It forms a layer of zinc complex $Na_2[Zn(CN)_4]$ on the surface of ZnS and therefore, prevents it from forming the froth. Therefore, it acts as a depressant.

Q9. Why is sulphide ore of copper heated in a furnace after mixing with silica?

Answer. Iron oxide present as an impurity in sulphide ore of copper forms slag which is iron silicate and copper is produced in the form of copper matter.
$FeO + SiO_2 \rightarrow FeSiO_3$

Q10. How are metals used as semiconductors refined? What is the principle of the method used?

Answer. Semiconducting metal is produced by the zone refining method which is based on the principle that the impurities are more stable in melt than in the solid state of metals.

Q11. Define metallurgy. Name the important metallurgical operations.

Answer. Metallurgy is defined as a process that is used for the extraction of metals in their pure form. Metallurgy deals with the process of purification of metals and the formation of alloys.

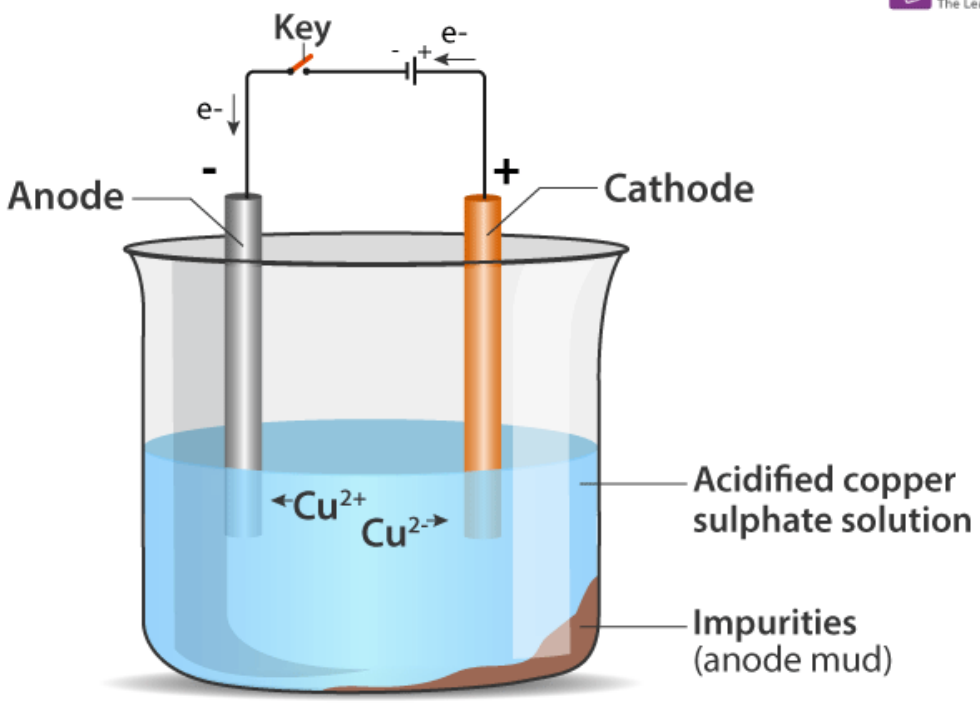
The following are the various steps in the metal extraction or metallurgical process:

- Crushing and grinding the ore.
- The concentration of ore is also known as ore enrichment.
- Metal extraction from concentrated ore.
- Impure metals are refined or purified.

Q12. What is electrorefining? Explain with one example.

Answer. Electrolytic refining is a technique that is used for the extraction and purification of metals that are obtained by refining methods. The impure metal is used as an anode and the pure metal is used as a cathode. Soluble salt from the same metal is used an electrolyte. When an electric current is passed, pure metal gets deposited at the cathode and the impure metal gets dissolved from the anode.
Impurities from the metal get collected below the anode and is known as anode mud.
In the electrolytic refining impurities such as gold, silver, platinum group metals, arsenic, selenium, and tellurium are recovered.

Electrolytic refining of copper is an example of electrolytic refining. A thin strip of pure copper metal is used as a cathode. A thick strip of impure copper metal is used as the anode.



Q13. (a) Why is zinc not extracted from zinc oxide through reduction with CO?
(b) Is carbon a satisfactory reducing agent for all metal oxides? Give reasons.

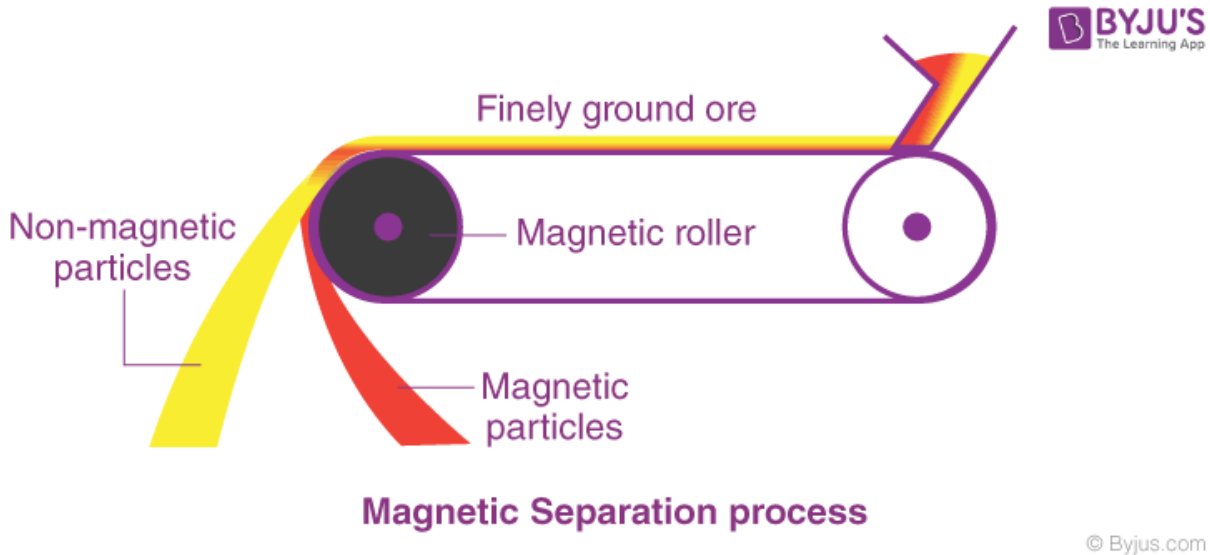
Answer. (a) ΔG° for the conversion of Zn into ZnO is - 650 KJ and for the conversion of CO into CO_2 is - 250 KJ i.e.,
$2Zn + O_2 \rightarrow 2ZnO$, $\Delta G^\circ = -650KJ$
$2CO + O_2 \rightarrow 2CO_2$, $\Delta G^\circ = -450KJ$
For the reaction
$2ZnO + 2CO \rightarrow 2Zn + 2CO_2$, $\Delta G^\circ = +200KJ$
Therefore, the positive value of ΔG° shows that the reaction is not feasible.
That's why CO cannot be used for the reduction of ZnO into Zn by Considering the Ellingham diagram.

(b) Carbon is not a good reducing agent for all metal oxides because it cannot reduce the oxides of highly electropositive metals such as Ca, Na, Mg, and so on, which are very stable in nature.

Q14. Discuss the froth floatation process and magnetic separation method for the concentration of ore.

Answer. Magnetic Separation:

This involves the use of magnetic properties of either the ore or the gangue to separate them. The ore is first ground to fine pieces and then passed on a conveyor belt passing over a magnetic roller. The magnetic ore remains on the belt and the gangue falls off the belt.



Magnetic Separation process

Froth Flotation Method:
This method is mainly used to remove gangue from sulphide ores. The ore is powdered and a suspension is created in the water. To this are added, Collectors and Froth Stabilizers. Collectors (pine oils, fatty acids etc) increase the non-wettability of the metal part of the ore and allows it to form a froth. Froth Stabilizers (cresols, aniline etc) sustain the froth. The oil wets the metal and the water wets the gangue. Paddles and air constantly stir up the suspension to create the froth. This frothy metal is skimmed off the top and dried, to recover the metal.

Q15. Differentiate between the following:
(a) Roasting and calcination
(b) Minerals and ores
(c) Gangue and flux

Answer.
(a)

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 the 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.

(b)

Minerals	Ores
All the naturally occurring substances that are present in the earth's crust are known as Minerals.	Ores are usually used to extract metals economically. A large number of ores are present.
All Minerals are not ores.	All ores are minerals.
Minerals are native forms in which metals exist.	Ores are mineral deposits.

(c) Gangue is the earthly or undesired materials (impurities) that are present in the ores mined from the earth's surface whereas flux is a substance that chemically combines with gangue (earthly impurities) which may still be present in the calcined or roasted ore to form easily fusible material called the slag.

Q16. (a) Which solution is used for the leaching of silver metal in the presence of air in the metallurgy of silver?
(b) Out of C and CO, which is a better reducing agent at the lower temperature range in the blast furnace to extract iron from the oxide ore?

Answer. (a) In silver and gold metallurgy, the respective metal is leached with a dilute solution of NaCN or KCN in the presence of air (for example O_2).

(b) CO is a better reducing agent in the blast furnace at lower temperatures (500-800 K) to extract iron from oxide ore.

Q17. (a) What is flux? Give one example each of an acid and a basic flux.
(b) Why are metallic ores converted into oxide usually?
(c) Discuss the process of leaching with reference to the extraction of aluminium.

Answer. (a) Flux is a substance that chemically combines with gangue (earthly impurities) which may still be present in the calcined or roasted ore to form easily fusible material called the slag.
Acid flux: SiO_2 (sand)
Basic flux: CaO (lime)

(b) It is easier to obtain metals from their oxides (by reduction) than from carbonates or sulphides. So before reduction can be done, the ore is converted into metal oxide. The concentrated ores can be converted into metal oxide by calcination or roasting.

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

Q18. 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?

Answer. (i) Down's process is used for the manufacture of Na metal.
When molten NaCl is subjected to electrolysis, chlorine is obtained as a by-product at the anode because in the molten state only Na^+ and Cl^- ions are present.
$NaCl \rightarrow Na^+ + Cl^-$
At cathode: $Na^+ + e^-$
At anode: $Cl^- \rightarrow Cl + e^-$
$2Cl \rightarrow Cl_2$
(ii) When an aqueous solution of NaCl is electrolysed H^+ ions are reduced in preference to Na at the cathode and H_2 gas is released. Na^+ remains in the solution and forms NaOH with OH^- ions. Chlorine gas is obtained at the anode as a by-product,

$NaCl \rightarrow Na^+ + Cl^-$
$H_2O \rightleftarrows H^+ + OH^-$

At cathode: $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$
At anode: $Cl^- \rightarrow Cl + e^-$
$2Cl \rightarrow Cl_2$

H_2 gas is obtained at the cathode; chlorine gas Cl_2 at the anode (as by-product) and NaOH is formed in the solution.
$Na^+ + OH^- \rightarrow NaOH$

Q19. What is the role of the graphite rod in the electrometallurgy of aluminium?

Answer. In aluminium electrometallurgy, a fused mixture of purified alumina (Al_2O_3), cryolite (Na_3AlF_6), and fluorspar (CaF_2) is electrolyzed. The anode in this electrolysis is graphite, and the cathode is graphite-lined iron. According to the following equation, during electrolysis, Al is liberated at the cathode, while CO and CO_2 are liberated at the anode.

Cathode: $Al^{3+} + 3e^- \rightarrow Al$

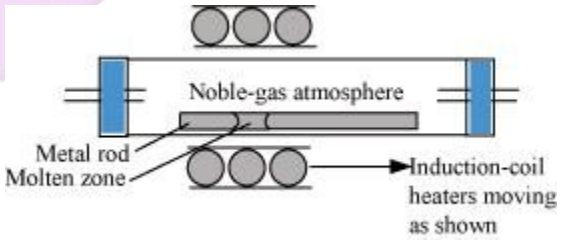
Anode: $C + 2O^{2-} \rightarrow CO + 2e^-$

$C + 2O^{2-} \rightarrow CO_2 + 4e^-$

When a metal is used as the anode instead of graphite, O_2 is liberated. This will not only oxidise the electrode metal, but it will also convert some of the Al liberated at the cathode back into Al_2O_3. As a result, graphite is used to prevent the formation of O_2 at the anode. Furthermore, graphite is less expensive than other metals.

Q20. Explain-
(i) Zone refining
(ii) Column chromatography

Answer.
(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. Al2O3 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).