CHAPTER

13

General Principles and Processes of Isolation of Metals

1. In the leaching method, bauxite ore is digested with a concentrated solution of NaOH that produces '*X*'. When CO_2 gas is passed through the aqueous solution of '*X*', a hydrated compound '*Y*' is precipitated. '*X*' and '*Y*' respectively are

(a) $Na[Al(OH)_4]$ and $Al_2O_3 \cdot xH_2O$

(b) $Al(OH)_3$ and $Al_2O_3 \cdot xH_2O$

(c) $Na[Al(OH)_4]$ and $Al_2(CO_3)_3 \cdot xH_2O$

(d) $NaAlO_2$ and $Al_2(CO_3)_3 \cdot xH_2O$. *(Online 2018)*

2. In the extraction of copper from its sulphide ore, metal is finally obtained by the oxidation of cuprous sulphide with

(a) CO (b) Cu_2O

(c) Fe_2O_3 (d) SO_2 *(Online 2018)*

3. The following reaction occurs in the blast furnace where iron ore is reduced to iron metal :

$$Fe_2O_{3(s)} + 3CO_{(g)} \rightleftharpoons 2Fe_{(l)} + 3CO_{2(g)}$$

Using the Le Chatelier's principle, predict which one of the following will not disturb the equilibrium?

(a) Addition of Fe_2O_3 (b) Removal of CO_2

(c) Removal of CO (d) Addition of CO_2

(Online 2017)

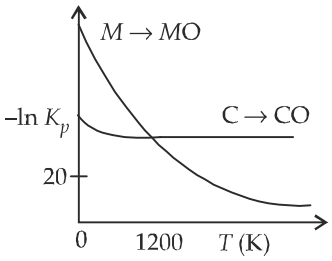
4. Which one of the following ores is best concentrated by froth floatation method ?

(a) Magnetite (b) Siderite

(c) Galena (d) Malachite *(2016)*

5. The plot shows the variation of $-\ln K_p$ versus temperature for the two reactions.

$$M_{(s)} + \frac{1}{2}O_{2(g)} \rightarrow MO_{(s)} \text{ and } C_{(s)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{(g)}$$



Identify the correct statement.

(a) At $T < 1200$ K, oxidation of carbon is unfavourable.

(b) Oxidation of carbon is favourable at all temperatures.

(c) At $T < 1200$ K, the reaction $MO_{(s)} + C_{(s)} \rightarrow M_{(s)} + CO_{(g)}$ is spontaneous.

(d) At $T > 1200$ K, carbon will reduce $MO_{(s)}$ to $M_{(s)}$.

(Online 2016)

6. Extraction of copper by smelting uses silica as an additive to remove

(a) Cu_2O (b) FeS

(c) FeO (d) Cu_2S *(Online 2016)*

7. In the isolation of metals, calcination process usually results in

(a) metal carbonate (b) metal oxide

(c) metal sulphide (d) metal hydroxide.

(Online 2015)

8. Calamine is an ore of

(a) aluminium (b) copper

(c) iron (d) zinc. *(Online 2015)*

9. Which series of reactions correctly represents chemical relations related to iron and its compound?

(a) $Fe \xrightarrow{O_2,\ heat} Fe_3O_4 \xrightarrow{CO,\ 600\ °C} FeO \xrightarrow{CO,700\ °C} Fe$

(b) $Fe \xrightarrow{dil.\ H_2SO_4} FeSO_4 \xrightarrow{H_2SO_4,\ O_2} Fe_2(SO_4)_3 \xrightarrow{heat} Fe$

(c) $Fe \xrightarrow{O_2,\ heat} FeO \xrightarrow{dil.\ H_2SO_4} FeSO_4 \xrightarrow{heat} Fe$

(d) $Fe \xrightarrow{Cl_2,\ heat} FeCl_3 \xrightarrow{heat,\ air} FeCl_2 \xrightarrow{Zn} Fe$

(2014)

10. Which method of purification is represented by the following equation?

$$Ti_{(s)} + 2I_{2(g)} \xrightarrow{523\ K} TiI_{4(g)} \xrightarrow{1700\ K} Ti_{(s)} + 2I_{2(g)}$$

(a) Cupellation (b) Poling

(c) Van Arkel (d) Zone refining *(2012)*

11. Which of the following factors is of no significance for roasting sulphide ores to the oxides and not subjecting the sulphide ores to carbon reduction directly?

(a) CO_2 is more volatile than CS_2.

(b) Metal sulphides are thermodynamically more stable than CS_2.

(c) CO_2 is thermodynamically more stable than CS_2.

(d) Metal sulphides are less stable than the corresponding oxides.

(2008)

12. During the process of electrolytic refining of copper, some metals present as impurity settle as 'anode mud'. These are
(a) Sn and Ag (b) Pb and Zn
(c) Ag and Au (d) Fe and Ni. *(2005)*

13. Which one of the following ores is best concentrated by froth-flotation method?
(a) Magnetite (b) Cassiterite
(c) Galena (d) Malachite. *(2004)*

14. When the sample of copper wth zinc impurity is to be purified by electrolysis, the appropriate electrodes are

	Cathode	**Anode**
(a)	pure zinc	pure copper
(b)	impure sample	pure copper
(c)	impure zinc	impure sample
(d)	pure copper	impure sample. *(2002)*

15. Cyanide process is used for the extraction of
(a) barium (b) aluminium
(c) boron (d) silver. *(2002)*

16. The metal extracted by leaching with a cyanide is
(a) Mg (b) Ag
(c) Cu (d) Na. *(2002)*

17. Aluminium is extracted by the electrolysis of
(a) bauxite (b) alumina
(c) alumina mixed with molten cryolite
(d) molten cryolite. *(2002)*

ANSWER KEY

1. (a) **2.** (b) **3.** (a) **4.** (c) **5.** (c) **6.** (c) **7.** (b) **8.** (d) **9.** (a) **10.** (c) **11.** (a) **12.** (c)
13. (c) **14.** (d) **15.** (d) **16.** (b) **17.** (c)

Explanations

1. (a) : When bauxite ore is digested with concentrated NaOH solution, alumina (Al_2O_3) dissolves.

$$Al_2O_{3(s)} + 2NaOH_{(aq)} + 3H_2O_{(l)} \xrightarrow{473-523\ K}$$

$$\underset{\text{Sodium meta-aluminate}}{2Na[Al(OH)_4]_{(aq)}} \xrightarrow{CO_2} \underset{\text{Hydrated alumina}}{Al_2O_3.xH_2O_{(s)}\downarrow} + 2NaHCO_{3(aq)}$$

(*X*) (*Y*)

2. (b) : In the extraction of copper from its sulphide ore, the metal is obtained by auto-reduction. A part of sulphide ore is converted into oxide which then reacts with remaining sulphide to give the metal.

$$2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2$$

$$2Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2$$

3. (a)

4. (c) : Froth floatation method is suitable for sulphide ores thus, PbS *i.e.*, galena is best concentrated by this method.

5. (c) : In the given Ellingham diagram, below 1200 K the C → CO curve lies below the $M \rightarrow MO$ curve hence, carbon can reduce *M*O.

6. (c) : To remove the gangue (FeO) in the extraction of copper, SiO_2 is added as flux to form slag ($FeSiO_3$).

$$FeO + SiO_2 \longrightarrow FeSiO_3$$

7. (b) : Metal oxide results in the process of calcination (heating ore in absence of air). *e.g.*, Calcium carbonate gives calcium oxide.

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$

8. (d) : Calamine ($ZnCO_3$) is an ore of zinc.

9. (a) : Formation of Fe_3O_4 through Fe, corresponds to the combustion of Fe and rest part of the reactions correspond to the production of Fe by reduction of Fe_3O_4 in blast furnace.

10. (c) : Van Arkel method which is also called as vapour-phase refining is used for preparing ultrapure metals like titanium, zirconium, thorium and uranium.

11. (a) : Oxidising roasting is a very common type of roasting in metallurgy and is carried out to remove sulphur and arsenic in the form of their volatile oxides.CS_2 is more volatile than CO_2. So option (a) is of no significance for roasting sulphide ores to their oxides. The reduction process is on the thermodynamic stability of the products and not on their volatility.

12. (c) : In the electrolytic refining of copper the more electropositive impurities like Fe, Zn, Ni, Co, etc. dissolve in the solution and less electropositive impurities such as Ag, Au and Pt collect below the anode in the form of anodic mud.

13. (c) : Froth-flotation method is used for the concentration of sulphide ores. The method is based on the preferential wetting properties with the frothing agent and water. Here galena (PbS) is the only sulphide ore.

14. (d) : The impure metal is made anode while a thin sheet of pure metal acts as cathode. On passing the current, the pure metal is deposited on the cathode and equivalent amount of the metal gets dissolved from the anode.

15. (d) : Gold and silver are extracted from their native ores by Mac-Arthur forrest cyanide process.

16. (b) : Silver ore forms a soluble complex with NaCN from which silver is precipitated using scrap zinc.

$$Ag_2S + 2NaCN \rightarrow Na[Ag(CN)_2] \xrightarrow{Zn} \underset{\substack{\text{sod. argentocyanide}\\ \text{(soluble)}}}{Na_2[Zn(CN)_4]} + Ag\downarrow$$

17. (c) : Aluminium is obtained by the electrolysis of the pure alumina (20 parts) dissolved in a bath of fused cryolite (60 parts) and fluorspar (20 parts).