CHAPTER 13- METALLURGY

Single Correct Type

1. $Ore + CN^- + H_2O \xrightarrow{O_2} X \xrightarrow{Zn} Y + metal.$ X and Y in this reaction is

   (A) $X = \left[Ag(CN)_2\right]^-$; $Y = \left[Zn(CN)_4\right]^{2-}$ (B)

   $X = \left[Ag(CN)_4\right]^{2-}$; $Y = \left[Zn(CN)_4\right]^{2-}$

   (C) $X = \left[Au(CN)_2\right]^-$; $Y = \left[Zn(CN)_4\right]^{2-}$ (D) (A) and (C)

2. Which of the following is incorrect?
   (A) Flux is used to fuse non-fusible impurities present in ore.
   (B) All ores are minerals
   (C) Refractory materials are generally used in furnaces because they are chemically inert.
   (D) Main function of roasting is to remove volatile impurities

3. Silica is added to roasted copper ore during extraction in order to remove:
   (A) Cuprous sulphide   (B) ferrous oxide
   (C) ferrous sulphide   (D) cuprous oxide

4. In the manufacture of Mg by Carbon reduction of MgO, why is the product cooled in the stream of an inert gas
   (A) to enhance Mg formation
   (B) Mg reacts with CO to form $Mg(CO_3)_2$
   (C) to prevent reversible reaction
   (D) None of these

5. Which method of purification is represented by the following equations?

   $Ti + 2I_2 \xrightarrow{773K} TiI_4 \xrightarrow{1675K} Ti + 2I_2$

   (A) Cupellation   (B) Poling
   (C) Van-Arkel   (D) Zone refining

6. Ethyl Xanthate and potassium ethyl xanthate are used as:
   (A) Depressants   (B) Foaming agent
   (C) Collectors   (D) None of these

7. In Mond's process nickel is purified by using:
   (A) CO_2 gas   (B) CO gas
   (C) SO_2 gas   (D) O_3 gas

8. In the Mond's process of refining of Nickel metal, impure metal is heated with a stream of carbon monoxide which forms a volatile
   (A) Square planar tetracarbonylnickel(0)

(B) Octahedral hexacarbonylnickel(0)

(C) Tetrahedral tetracarbonylnickel(0)

(D) Trigonaltricarbonylnickel(0)

9. Which of the following is wrong?

(A) The ore zinc blende is concentrated by froth floatation process.

(B) Van Arkel method is used for refining Zirconium.

(C) Calamine is a carbonate ore.

(D) The alloy german silver contain 61% of silver

10. Electrostatic beneficiation can be employed for the separation of

(A) Silicate and carbonate ore

(B) Sulphide and oxide ore

(C) Phosphate and carbonate ore

(D) Carbonate and sulphide ore

Multiple Correct Type

11. The chief reaction(s) occurring in blast furnace during extraction of iron from haematite is/are:

    (A) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

    (B) $FeO + SiO_2 \rightarrow FeSiO_3$

    (C) $Fe_2O_3 + C \rightarrow 2Fe + 3CO$

    (D) $CaO + SiO_2 \rightarrow CaSiO_3$

12. Which of the following will respond positively to the chromyl chloride test?

    (A) $CuCl_2$ (B) $ZnCl_2$

    (C) $HgCl_2$ (D) $AgCl$

13. $K_4[Fe(CN)_6]$ is used for the detection of

    (A) Fe^{2+} (B) Fe^{3+}

    (C) Cu^{2+} (D) Zn^{2+}

14. Which of the following does not respond to chromyl chloride test?

    (A) NH_4Cl (B) KCl

    (C) $HgCl_2$ (D) $SnCl_4$

15. Which of the following oxides dissolve in sodium hydroxide forming corresponding salts.

(A) Al_2O_3 (B) ZnO

(C) SnO_2 (D) PbO_2

16. In which of the following pairs, the minerals are converting into metals by self-reduction?

(A) Ag_2S, ZnS (B) Cu_2S, HgS

(C) PbS, ZnS (D) Cu_2S, PbS

17. Which of the following is/are applicable for the basic furnace lining in steel manufacture?

(A) Basic lining involve the presence of SiO_2

(B) Basic lining involve the presence of CuO

(C) Basic lining involve the presence of MgO

(D) basic linings are used to remove the acidic impurities like P_4O_{10}, SO_2, etc

18. Roasting of copper pyrites is done

(A) to remove moisture.

(B) to oxidize free sulphur

(C) to decompose sulphides into oxides.

(D) to remove volatile organic impurities

19. Extraction of gold is done by the following process

$$Au + CN^- \longrightarrow (X)$$

$$(X) + Zn \longrightarrow (Y) + Au\downarrow$$

Incorrect (X) and (Y) are

(A) $[Au(CN)_2]^-$, $[Zn(CN)_4]^{2-}$ (B) $[Au(CN)_2]^-$, $[Zn(CN)_6]^{4-}$

(C) $[Au(CN)_4]^{3-}$, $[Zn(CN)_2]$ (D) $[Au(CN)_4]^-$, $[Zn(CN)_4]^-$

20. Find out the incorrect statement.

(A) In the extraction metallurgy of copper silica removes Fe_2O_3 present in the matte by forming $FeSiO_3$

(B) Cast iron has lower carbon content than pig iron

(C) Out of carbon & carbon monoxide (CO), CO is a better reducing agent than carbon for ZnO

(D) Cryolite is used in the extractive metallurgy of aluminum only to lower the melting point of the mixture.

Integer Type

21. Out of given sulphide ppt of group II radicals (Hgs, Pbs, Bi_2S_3, Cus, Cds). The sum total of all the black and yellow ppt. will be?

22. Suppose you have given certain reagents like:

$K_2Cr_2O_7 / H^+$; H_2SO_4 (Conc.); H_2SO_4 (dil.) $AgNO_3$ Solution

How many of them can be used to detect Cl^- & NO_3^- radicals for given sample?

23. Green vitriol $\xrightarrow{300^\circ C}$ anhydrous salt $\xrightarrow[\text{temp}]{\text{high}}$ L + M + N. If oxidation state of the central atom in L, M, N are X, Y, Z respectively (X<Y<Z). The value of $Y + Z - X$ is ____

24. Compounds viz.

$$\underset{(1)}{Na_2SO_3}, \underset{(2)}{NaCl}, \underset{(3)}{Na_2C_2O_4}, \underset{(4)}{Na_2HPO_4}, \underset{(5)}{NaNO_2}, \underset{(6)}{Na_2CrO_4}, \underset{(7)}{CH_3COONa}$$

when treated separately with $AgNO_3$ solution, how many of them give a white precipitate?

25. A mixture contains AgCl, Al(OH)$_3$, Zn(OH)$_2$, Cu(OH)$_2$. On adding excess of NH$_4$OH how many of them will transfer into filtrate?

26. The number of water molecules attached with microcosmic salt is

27. How many of the following ores are carbonate type? Cuprite, Malachite, Siderite, Bauxite, Zincite, Calamine, Limonite, Azurite, Cerussite, Carnalite, Dolomite.

28. Sea water contains 1297.3g of Mg^{2+} per metric ton . How much of slaked lime in kg. Must be added to 1.0 metric ton of sea water to precipitate all of the Mg^{2+} ion.

29. $Ag_2S + NaCN + Zn \rightarrow Ag + 'W'$

In 'W' the coordination number of Zn is –

30. Among the sulphide ores of Ag, Hg, Pb, Fe, Cu and Zn, how many of them can be extracted by self-reduction process.

SOLUTIONS

Single Correct Type

1. **(D)**

   The reaction mentioned in the question is nothing but cyanide process which is used for the extraction of silver and gold from their respective ores. The reaction for the extraction is as follows:

   $$Zn + 2Na[Ag(CN)_2] \longrightarrow Na_2[Zn(CN)_4] + 2Ag$$

   $$Zn + 2Na[Au(CN)_2] \longrightarrow Na_2[Zn(CN)_4] + 2Au$$
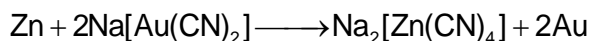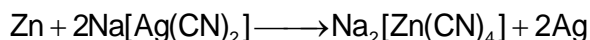
2. **(C)**

   For A), The flux combines with the gangue and forms a easily fusible mass called slag. The slag can be very easily removed from the contents. Gangue + flux = slag. Flux functions on acidic or basic nature of gangue. There are two types of flux, Acidic flux and Basic Flux. Acidic flux is used to remove gangue having basic nature. Basic flux is used to remove gangue having acidic nature.

   For B), A mineral is the native form in which the metal exists. An ore is a mineral from which the metal can be extracted economically. For example, Clay is mineral of Aluminium but Bauxite is an ore of Aluminium. Thereby all ores are minerals but not all minerals are ores.

   For C), A refractory material is one that retains its strength at high temperatures. That is why furnaces are lined with refractory bricks.

For D), The process of heating an ore alone (or) mixed with other substances in air below its melting point is known as roasting. Roasting process removes volatile impurities from the ore.

3. (B)

Copper sulfide and iron oxide can mix, but when sufficient silica is added, a separate slag layer is formed. Adding silica also reduces the melting point (or, more properly, the liquidus temperature) of the slag, meaning that the smelting process can be operated at a lower temperature. The slag forming reaction is:

$$FeO + SiO_2 \rightarrow FeO.SiO_2$$
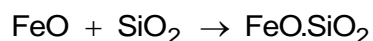
Slag is less dense than matte, so it forms a layer that floats on top of the matte.

4. (C)

The reduction of MgO is a reversible process. In order to prevent the reaction between Mg and CO, the temperature of the products is reduced in a stream of an inert gas. Inert gas does not permit the reaction of Mg with air.

$$MgO + C \rightleftharpoons Mg + CO$$
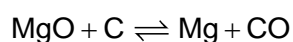
5. (C)

Ultra-pure metals are being prepared by the Van Arkel Method. Crude metal is heated with a suitable substance so that the pure metal present in it may be converted into stable volatile compound leaving behind impurities. The compound so formed is then decomposed by heating to get the pure metal. Van Arkel's method is used to purify crude titanium metal. It is heated with iodine to about 773K to form volatile compound. TiI_4 leaving behind the impurities. TiI_4 is further heated to approximately 1700K when it decomposes to give pure titanium.

$$Ti + 2I_2 \xrightarrow{773K} TiI_4 \xrightarrow{1675K} Ti + 2I_2$$

6. (C)

In froth flotation process, the ground ore is mixed with water to form a slurry and the desired mineral is rendered hydrophobic by the addition of a surfactant or collector chemical (although some mineral surfaces are naturally hydrophobic, requiring little or no addition of collector). The particular chemical depends on the nature of the mineral to be recovered and, perhaps, the natures of those that are not wanted. As an example, sodium ethyl xanthate may be added as a collector in the selective flotation of galena (lead sulfide) to separate it from sphalerite (zinc sulfide).

7. (B)

The Mond process, sometimes known as the carbonyl process, is a technique created by Ludwig Mond in 1890 to extract and purify nickel. This process converts nickel oxides into pure nickel.

This process makes use of the fact that carbon monoxide combines with nickel readily and reversibly to give nickel carbonyl. No other element forms a carbonyl compound under the mild conditions used in the process. This process has three steps:

1. Nickel oxide reacts with Syngas at 200 °C to give Nickel, together with impurities including Iron and Cobalt.

$$NiO(s) + H_2(g) \rightarrow Ni(s) + H_2O(g)$$
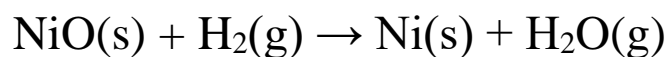
2. The impure Nickel reacts with Carbon monoxide at 50–60 °C to form the gaseous Nickel carbonyl, leaving the impurities as solids.

$$Ni(s) + 4\ CO(g) \rightarrow Ni(CO)_4(g)$$
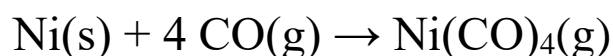
3. The mixture containing Nickel carbonyl (and synthesis gas) is heated to 220–250 °C, resulting in decomposition back to Nickel and Carbon monoxide:

$$Ni(CO)_4(g) \rightarrow Ni(s) + 4\ CO(g)$$
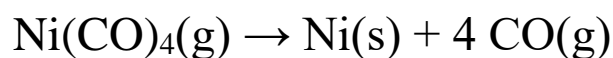
8. (C)

In Mond's process, Impure Nickel is heated with a stream of Carbon Monoxide to form a volatile complex compound, Nickel tetracarbonyl. The complex on heating at higher temperature gives off pure Nickel.

$$Ni + 4CO \xrightarrow{70°C} Ni(CO)_4 \xrightarrow{180°C} Ni + 4CO$$

[Ni(CO)$_4$]

↓

Ni $\longrightarrow$ [Ar]^{18} 4s^2 3d^8

3d   4s   4p
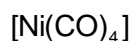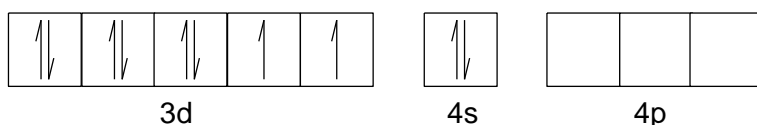
Due to strongly interacting ligand, carbonyl (CO), electrons of 4s pair up in 3d. Electronic configuration of Nickel in Ni(CO)$_4$ is

3d   4s   4p

sp^3
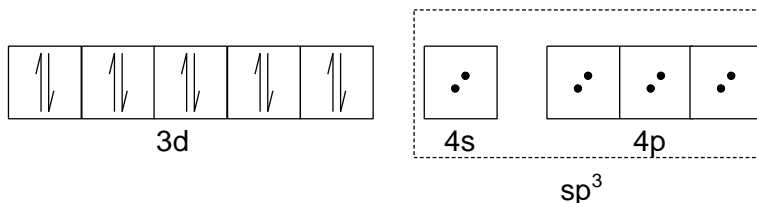
As hybridization of Ni in [Ni(CO)$_4$] is sp^3, shape is Tetrahedral.

9. (D)

For (1), Concentration of suphide ores is done by froth titration process.

For (2), Van Arkel Method is used for it used for the purification of metals. Titanium and Zircanium can be purified by this method.

For (3), Calamine is zinc ore (Zinc carbonate)

For (4), German silver is a copper alloy with Nickel and Zinc. It contains 60% copper, 20% Nickel and 20% Zinc.

10. (D)

Electrostatic beneficiation i.e. concentration method is used to separate constituents of ore having different electrical conductivities. This technique mainly separates conductors and non−conductors. Metallic sulphide and oxide ores are conductors while silicates, carbonates and phosphates are non−conductors. So, a mixture having sulphide and carbonate ore can be separated by this method.

Multiple Correct Type

11. (A, D)

In extraction of Fe, Fe_2O_3 is primary reduced by CO below 710°C and acidic impurity of SiO_2 is removed in the form of $CaSiO_3$ (slag).

12. (C, D)
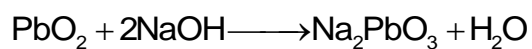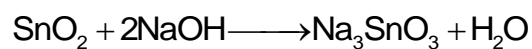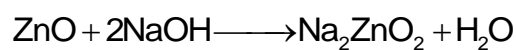$HgCl_2$ and AgCl are covalent in nature and insoluble in H_2O.
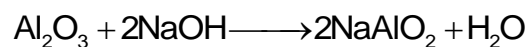
13. (B,C,D)

$Fe^{3+} \longrightarrow Fe_4\left[Fe(CN)_6\right]_3$ Prussian blue

$Cu^{2+} \longrightarrow Cu_2\left[Fe(CN)_6\right]$ Reddish brown

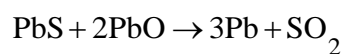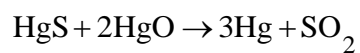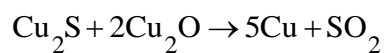$Zn^{2+} \longrightarrow Zn_2\left[Fe(CN)_6\right]$ Bluish white
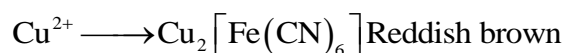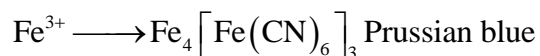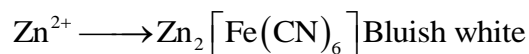
14. (C, D)

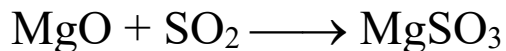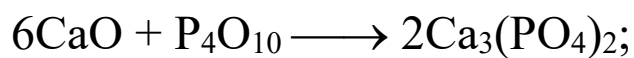Covalent chlorides do not respond to chromyl chloride test, e.g., $SnCl_4$, $HgCl_2$

15. (A, B, C, D)

$Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$

$ZnO + 2NaOH \longrightarrow Na_2ZnO_2 + H_2O$

$SnO_2 + 2NaOH \longrightarrow Na_3SnO_3 + H_2O$

$PbO_2 + 2NaOH \longrightarrow Na_2PbO_3 + H_2O$

16. (B, D)

$Cu_2S + 2Cu_2O \rightarrow 5Cu + SO_2$

$HgS + 2HgO \rightarrow 3Hg + SO_2$

$PbS + 2PbO \rightarrow 3Pb + SO_2$

17. (B, C, D)

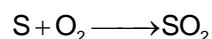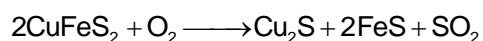$6CaO + P_4O_{10} \longrightarrow 2Ca_3(PO_4)_2$;
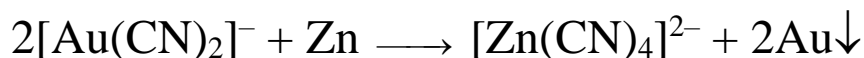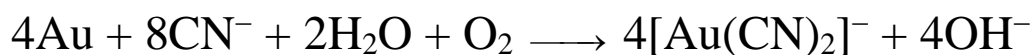
$MgO + SO_2 \longrightarrow MgSO_3$

18. (A, B, C, D)

The concentrated are (Copper Pyrite) is roasted in a furnace in presence of air current. During this process, sulphur is oxidized to SO_2, volatile organic impurities are removed, moisture is removed and sulphides decompose to give oxides.

$$2CuFeS_2 + O_2 \longrightarrow Cu_2S + 2FeS + SO_2$$

$$S + O_2 \longrightarrow SO_2$$

19. (B, C, D)

Extraction of gold is done by the following process:

$$4Au + 8CN^- + 2H_2O + O_2 \longrightarrow 4[Au(CN)_2]^- + 4OH^-$$

$$2[Au(CN)_2]^- + Zn \longrightarrow [Zn(CN)_4]^{2-} + 2Au\downarrow$$

20. (A, B, D)

Carbon is a better reducing agent than CO for reduction of zinc oxide.

Integer Type

21. (4)

$$\left.\begin{array}{l} HgS \\ PbS \\ CuS \end{array}\right\} \text{— Black}$$

Bi_2S_3 — Yellow Orange
CdS — Yellow

22. (4)

$$Cl^- \begin{array}{l} \longrightarrow K_2Cr_2O_7 \mid H^+ \\ \longrightarrow H_2SO_4(conc) \\ \longrightarrow H_2SO_4(dil) \end{array}$$

$$NO_3^- \xrightarrow{H_2SO_4(conc)}$$

23. (7)

$$FeSO_4.7H_2O \xrightarrow[-720]{300^O C} 2FeSO_4 \xrightarrow[\text{temp}]{\text{High}} Fe_2O_3 + SO_2 + SO_3$$
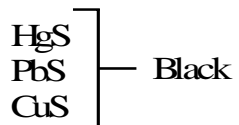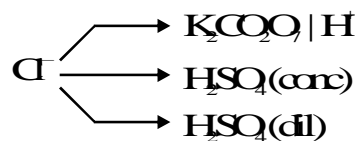
24. (5)

$Ag_2SO_3, AgCl, Ag_2C_2O_4, AgNO_2 \& CH_3COOAg$ are white ppts, while Ag_3PO_4 is yellow and Ag_2CrO_4 is red.

25. (3)

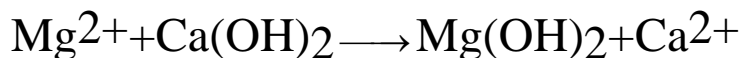AgCl, $Zn(OH)_2$, $Cu(OH)_2$ will dissolve in excess of NH_4OH.

26. (4)

$Na(NH_4)HPO_4 . 4H_2O$

27. (6)

Cuprite: Cu_2O, Malachite: $CuCO_3.Cu(OH)_2$, Siderite: $FeCO_3$, Bauxite: $Al_2O_3.2H_2O$, Zincite: ZnO; Calamine: $ZnCO_3$, Limonite: $2Fe_2O_3.3H_2O$. Azurite: $2CuCO_3.Cu(OH)_2$, Cerussite: $PbCO_3$, Carnalite: $KCl.MgCl_2.6H_2O$, Dolomite: $CaCO_3.MgCO_3$.

28. (4)

$$Mg^{2+}+Ca(OH)_2 \longrightarrow Mg(OH)_2+Ca^{2+}$$

24 g of Mg^{2+} is ppted ny 74g of $Ca(OH)_2$

1297.3 g Mg^{2+} is ppted ny $74g = \frac{74 \times 1297.3}{24}$

$=4000g$

$= 4 \text{ kg}$

29. (4)

Because $Ag_2S + NaCN + Zn \rightarrow Ag + Na_2\left[Zn(CN)_4\right]$

Zn has 4 coordination number

30. (3)

Hg, Pb and Cu are extracted by self-reduction process.