Unit

9

COORDINATION COMPOUNDS

I. Multiple Choice Questions (Type-I)

1. Which of the following complexes formed by Cu^{2+} ions is most stable?

(i) $Cu^{2+} + 4NH_3 \rightleftharpoons [Cu(NH_3)_4]^{2+}$, logK = 11.6

(ii) $Cu^{2+} + 4CN^- \rightleftharpoons [Cu(CN)_4]^{2-}$, logK = 27.3

(iii) $Cu^{2+} + 2en \rightleftharpoons [Cu(en)_2]^{2+}$, logK = 15.4

(iv) $Cu^{2+} + 4H_2O \rightleftharpoons [Cu(H_2O)_4]^{2+}$, logK = 8.9

2. The colour of the coordination compounds depends on the crystal field splitting. What will be the correct order of absorption of wavelength of light in the visible region, for the complexes, $[Co(NH_3)_6]^{3+}$, $[Co(CN)_6]^{3-}$, $[Co(H_2O)_6]^{3+}$

(i) $[Co(CN)_6]^{3-} > [Co(NH_3)_6]^{3+} > [Co(H_2O)_6]^{3+}$

(ii) $[Co(NH_3)_6]^{3+} > [Co(H_2O)_6]^{3+} > [Co(CN)_6]^{3-}$

(iii) $[Co(H_2O)_6]^{3+} > [Co(NH_3)_6]^{3+} > [Co(CN)_6]^{3-}$

(iv) $[Co(CN)_6]^{3-} > [Co(NH_3)_6]^{3+} > [Co(H_2O)_6]^{3+}$

3. When 0.1 mol $CoCl_3(NH_3)_5$ is treated with excess of $AgNO_3$, 0.2 mol of AgCl are obtained. The conductivity of solution will correspond to

(i) 1:3 electrolyte

(ii) 1:2 electrolyte

(iii) 1:1 electrolyte

(iv) 3:1 electrolyte

4. When 1 mol $CrCl_3 \cdot 6H_2O$ is treated with excess of $AgNO_3$, 3 mol of AgCl are obtained. The formula of the complex is :

(i) $[CrCl_3(H_2O)_3] \cdot 3H_2O$
(ii) $[CrCl_2(H_2O)_4]Cl \cdot 2H_2O$
(iii) $[CrCl(H_2O)_5]Cl_2 \cdot H_2O$
(iv) $[Cr(H_2O)_6]Cl_3$

5. The correct IUPAC name of $[Pt(NH_3)_2Cl_2]$ is

(i) Diamminedichloridoplatinum (II)
(ii) Diamminedichloridoplatinum (IV)
(iii) Diamminedichloridoplatinum (0)
(iv) Dichloridodiammineplatinum (IV)

6. The stabilisation of coordination compounds due to chelation is called the chelate effect. Which of the following is the most stable complex species?

(i) $[Fe(CO)_5]$
(ii) $[Fe(CN)_6]^{3-}$
(iii) $[Fe(C_2O_4)_3]^{3-}$
(iv) $[Fe(H_2O)_6]^{3+}$

7. Indicate the complex ion which shows geometrical isomerism.

(i) $[Cr(H_2O)_4Cl_2]^+$
(ii) $[Pt(NH_3)_3Cl]$
(iii) $[Co(NH_3)_6]^{3+}$
(iv) $[Co(CN)_5(NC)]^{3-}$

8. The CFSE for octahedral $[CoCl_6]^{4-}$ is 18,000 cm^{-1}. The CFSE for tetrahedral $[CoCl_4]^{2-}$ will be

(i) 18,000 cm^{-1}
(ii) 16,000 cm^{-1}
(iii) 8,000 cm^{-1}
(iv) 20,000 cm^{-1}

9. Due to the presence of ambidentate ligands coordination compounds show isomerism. Palladium complexes of the type $[Pd(C_6H_5)_2(SCN)_2]$ and $[Pd(C_6H_5)_2(NCS)_2]$ are

(i) linkage isomers
(ii) coordination isomers
(iii) ionisation isomers
(iv) geometrical isomers

10. The compounds $[Co(SO_4)(NH_3)_5]Br$ and $[Co(SO_4)(NH_3)_5]Cl$ represent

(i) linkage isomerism
(ii) ionisation isomerism

(iii) coordination isomerism
(iv) no isomerism

11. A chelating agent has two or more than two donor atoms to bind to a single metal ion. Which of the following is **not** a chelating agent?

(i) thiosulphato
(ii) oxalato
(iii) glycinato
(iv) ethane-1,2-diamine

12. Which of the following species is **not** expected to be a ligand?

(i) NO
(ii) NH_4^+
(iii) $NH_2CH_2CH_2NH_2$
(iv) CO

13. What kind of isomerism exists between $[Cr(H_2O)_6]Cl_3$ (violet) and $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$ (greyish-green)?

(i) linkage isomerism
(ii) solvate isomerism
(iii) ionisation isomerism
(iv) coordination isomerism

14. IUPAC name of $[Pt(NH_3)_2Cl(NO_2)]$ is :

(i) Platinum diaminechloronitrite
(ii) Chloronitrito-N-ammineplatinum (II)
(iii) Diamminechloridonitrito-N-platinum (II)
(iv) Diamminechloronitrito-N-platinate (II)

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

15. Atomic number of Mn, Fe and Co are 25, 26 and 27 respectively. Which of the following inner orbital octahedral complex ions are diamagnetic?

(i) $[Co(NH_3)_6]^{3+}$
(ii) $[Mn(CN)_6]^{3-}$
(iii) $[Fe(CN)_6]^{4-}$
(iv) $[Fe(CN)_6]^{3-}$

16. Atomic number of Mn, Fe, Co and Ni are 25, 26 27 and 28 respectively. Which of the following outer orbital octahedral complexes have same number of unpaired electrons?

(i) $[MnCl_6]^{3-}$
(ii) $[FeF_6]^{3-}$
(iii) $[CoF_6]^{3-}$
(iv) $[Ni(NH_3)_6]^{2+}$

17. Which of the following options are correct for $[Fe(CN)_6]^{3-}$ complex?

(i) d^2sp^3 hybridisation
(ii) sp^3d^2 hybridisation
(iii) paramagnetic
(iv) diamagnetic

18. An aqueous pink solution of cobalt(II) chloride changes to deep blue on addition of excess of HCl. This is because____________.

(i) $[Co(H_2O)_6]^{2+}$ is transformed into $[CoCl_6]^{4-}$
(ii) $[Co(H_2O)_6]^{2+}$ is transformed into $[CoCl_4]^{2-}$
(iii) tetrahedral complexes have smaller crystal field splitting than octahedral complexes.
(iv) tetrahedral complexes have larger crystal field splitting than octahedral complex.

19. Which of the following complexes are homoleptic?

(i) $[Co(NH_3)_6]^{3+}$
(ii) $[Co(NH_3)_4 Cl_2]^+$
(iii) $[Ni(CN)_4]^{2-}$
(iv) $[Ni(NH_3)_4Cl_2]$

20. Which of the following complexes are heteroleptic?

(i) $[Cr(NH_3)_6]^{3+}$
(ii) $[Fe(NH_3)_4 Cl_2]^+$
(iii) $[Mn(CN)_6]^{4-}$
(iv) $[Co(NH_3)_4Cl_2]$

21. Identify the optically active compounds from the following :

(i) $[Co(en)_3]^{3+}$
(ii) *trans*- $[Co(en)_2 Cl_2]^+$
(iii) *cis*- $[Co(en)_2 Cl_2]^+$
(iv) $[Cr(NH_3)_5Cl]$

22. Identify the correct statements for the behaviour of ethane-1, 2-diamine as a ligand.

(i) It is a neutral ligand.
(ii) It is a didentate ligand.

(iii) It is a chelating ligand.

(iv) It is a unidentate ligand.

23. Which of the following complexes show linkage isomerism?

(i) $[Co(NH_3)_5(NO_2)]^{2+}$

(ii) $[Co(H_2O)_5CO]^{3+}$

(iii) $[Cr(NH_3)_5SCN]^{2+}$

(iv) $[Fe(en)_2Cl_2]^+$

III. Short Answer Type

24. Arrange the following complexes in the increasing order of conductivity of their solution: $[Co(NH_3)_3Cl_3]$, $[Co(NH_3)_4Cl_2]Cl$, $[Co(NH_3)_6]Cl_3$, $[Cr(NH_3)_5Cl]Cl_2$

25. A coordination compound $CrCl_3 \cdot 4H_2O$ precipitates silver chloridewhen treated with silver nitrate. The molar conductance of its solution corresponds to a total of two ions. Write structural formula of the compound and name it.

26. A complex of the type $[M(AA)_2X_2]^{n+}$ is known to be optically active. What does this indicate about the structure of the complex? Give one example of such complex.

27. Magnetic moment of $[MnCl_4]^{2-}$ is 5.92 BM. Explain giving reason.

28. On the basis of crystal field theory explain why Co(III) forms paramagnetic octahedral complex with weak field ligands whereas it forms diamagnetic octahedral complex with strong field ligands.

29. Why are low spin tetrahedral complexes not formed?

30. Give the electronic configuration of the following complexes on the basis of Crystal Field Splitting theory.

$[CoF_6]^{3-}$, $[Fe(CN)_6]^{4-}$ and $[Cu(NH_3)_6]^{2+}$.

31. Explain why $[Fe(H_2O)_6]^{3+}$ has magnetic moment value of 5.92 BM whereas $[Fe(CN)_6]^{3-}$ has a value of only 1.74 BM.

32. Arrange following complex ions in increasing order of crystal field splitting energy (Δ_o) :

$[Cr(Cl)_6]^{3-}$, $[Cr(CN)_6]^{3-}$, $[Cr(NH_3)_6]^{3+}$.

33. Why do compounds having similar geometry have different magnetic moment?

34. $CuSO_4.5H_2O$ is blue in colour while $CuSO_4$ is colourless. Why?

35. Name the type of isomerism when ambidentate ligands are attached to central metal ion. Give two examples of ambidentate ligands.