1. In the coordination compound $K_4[Ni(CN)_4]$, the oxidation state of nickel is :
(a) – 1 (b) 0 (c) + 1 (d) + 2

2. Which of the following has an optical isomer ?
(a) $[CO\ (en)(NH_3)_2]^{2+}$ (b) $[Co\ (H_2O)(en)]^{3+}$
(c) $[Co(en)_2(NH_3)_2]^{3+}$ (d) $[Co(NH_3)_3Cl]^{+}$

3. A solution containing 2.675 g of $CoCl_3 . 6\ NH_3$ (molar mass = 267.5 g mol^{-1}) is passed through a cation exchanger. The chloride ions obtained in solution were treated with excess of $AgNO_3$ to give 4.78 g of AgCl (molar mass = 143.5 g mol^{-1}). The formula of the complex is (At. mass of Ag = 108 u)
(a) $[Co(NH_3)_6\ ]\ Cl_3$ (b) $[CoCl_2\ (NH_3)_4]\ Cl$
(c) $[CoCl_3(NH_3)_3]$ (d) $[CoCl(NH_3)_5]\ Cl_2$

4. Which of the following facts about the complex $[Cr(NH_3)_6]Cl_3$ is wrong?
(a) The complex involves d^2sp^3hybridisation and is octahedral in shape.
(b) The complex is paramagnetic.
(c) The complex is an outer orbital complex.
(d) The complex gives white precipitate with silver nitrate solution.

5. The magnetic moment (spin only) of $[NiCl_4]^{2-}$ is :
(a) 1.82 BM (b) 5.46 BM
(c) 2.82 BM (d) 1.41 BM

6. The formula of the complex tris(ethylenediamine)cobalt(III) sulphate is :
(a) $[Co(en)_2SO_4]$ (b) $[Co(en)_3SO_4]$
(c) $[Co(en)_3]_2SO_4$ (d) $[Co(en)_3]_2SO_4$

7. A coordination compound of cobalt has the molecular formula containing five ammonia molecules, one nitro group and two chlorine atoms for one cobalt atom. One mole of this compound produces three moles of ions in an aqueous solution. The aqueous solution on treatment with an excess of $AgNO_3$ gives two moles of AgCl as a precipitate. The formula of this complex would be
(a) $[Co(NH_3)_4(NO_2)Cl]\ [(NH_3)Cl]$
(b) $[Co(NH_3)_5Cl]\ [ClNO_2]$
(c) $[Co(NH_3)_5(NO_2)]Cl_2$
(d) $[Co(NH_3)_5][(NO_2)_2Cl_2]$

8. The complex $[Pt(NH_3)_4]^{2+}$ has ..... structure :
(a) Square planar (b) Tetrahedral
(c) Pyramidal (d) Pentagonal

9. Which is not a π-bonded complex?
(a) Zeise's salt (b) Ferrocene
(c) Bis(benzene) chromium (d) Tetraethyl lead

10. Formula of ferrocene is:
(a) $[Fe(CN)_6]^{4-}$ (b) $[Fe(CN)_6]^{3+}$
(c) $[Fe(CO)_5]$ (d) $[Fe(C_5H_5)_2]$

11. Of the following complex ions, one exhibits isomerism. That is :
(a) $[Ag(NH_3)_2]^{+}$ (b) $[Co(NH_3)_5NO_2]^{2+}$
(c) $[Pt(en)Cl_2]$ (d) $[Co(NH_3)_5Cl]^{2+}$

12. Which one of the following high-spin complexes has the largest CFSE (Crystal field stabilization energy)?
(a) $[Mn(H_2O)_6]^{2+}$ (b) $[Cr(H_2O_6)]^{2+}$

(c) $[Mn(H_2O)_6]^{3+}$ (d) $[Cr(H_2O)_6]^{3+}$

13. A square planar complex is formed by hybridization of which atomic orbitals?

(a) s, p_x, p_y, d_{yz} (b) s, p_x, p_y, d_{x2-y2}

(c) s, p_x, p_y, d_{z2} (d) s, p_x, p_y, $d_{x\ y}$

14. Which of the following is/are paramagnetic ?

(a) $[Fe(CN)_6]^{4-}$ (b) $[Ni(CO)_4]$

(c) $[Ni(CN)_4]^{2-}$ (d) $[CoF_6]^{3-}$

15. In which of the following pairs, both the complexes show optical isomerism ?

(a) cis-$[Cr(C_2O_4)_2Cl_2]^{3-}$, cis-$[Co(NH_3)_4Cl_2]$ (b) $[Co(en)_3]Cl_3$,cis-$[Co(en)_2Cl_2]Cl$

(c) [PtCl(dien)Cl] , $[NiCl_2Br_2]^{2-}$ (d) $[Co(NO_3)_3(NH_3)_3]$, cis-$[Pt(en)_2Cl_2]$

16. The correct order for the wavelength of absorption in the visible region is :

(a) $[Ni(NO_2)_6]^{4-} < [Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+}$ (b) $[Ni(NO_2)_6]^{4-} < [Ni(H_2O)_6]^{2+} < [Ni(NH_3)_6]^{2+}$

(c) $[Ni(H_2O)_6]^{2+} < [Ni(NH_3)_6]^{2+} < [Ni(NO_2)_6]^{4+}$ (d) $[Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+} < [Ni(NO_2)_6]^{4-}$

17. When $AgNO_3$ is added to a solution of $Co(NH_3)_5Cl_3$, the precipitate of AgCl shows two ionizable chloride ions. This means :

(a) Two chlorine atoms satisfy primary valency and one secondary valency
(b) One chlorine atom satisfies primary as well as secondary valency
(c) Three chlorine atoms satisfy secondary valency
(d) Three chlorine atoms satisfy secondary valency

18. The hypothetical complex Chlorodiaquatriamminecobalt (III) chloride can be represented as

(a) [$CoCl(NH_3)_3$ $(H_2O)_2]Cl_2$ (b) [$Co(NH_3)_3$ $(H_2O)]Cl_3]$

(c) $[Co(NH_3)_3$ $(H_2O)_2]Cl]$ (d) $[Co(NH_3)_3$ $(H_2O)_3]Cl_3$

19. Which one amongst of the following isomerism is shown by $[Pt(NH_{32}Cl_2)]$?

(a) Structural (b) Geometrical
(c) Optical (d) Conformational

20. $[Fe(H_2O)_5NO]^{2+}$ is a complex formed during the brown ring test for NO_3^- ion. In this complex

(a) There are three unpaired electron so that its magnetic moment is 3.87 BM
(b) NO transfer its electron to Fe^{2+} so that iron as Fe(I) and NO as NO^+
(c) The colour is because of charge transfer
(d) All of the above statements are correct.

21. Mixture X = 0.02 mole of $[Co(NH_3)_5SO_4]Br$ and 0.02 mole of $[Co(NH_3)_5Br]SO_4$ was prepared in 2L of solution

1 L of mixture X + excess $AgNO_3 \longrightarrow$ Y
1 L of mixture X + excess $BaCl_2 \longrightarrow$ Z
Number of moles Y and Z are
(a) 0.03, 0.02 (b) 0.01, 0.02
(c) 0.02, 0.01 (d) 0.02, 0.02

22. $CuSO_4$. $5H_2O$ is blue in colour while $CuSO_4$ is colourless, because

(a) H_2O is a strong field ligand than SO_4^{2-}
(b) SO_4^{2} is a strong field ligand
(c) $CuSO_4$ cannot form the complex
(d) No d-d transition is possible in $CuSO_4$

23. Trien is

(a) Hexa dentate, Mono anionic
(b) tetradentate, neutral
(c) tetradentate, dianion
(d) Mono dentate, anion

24. Which of the following is diamagnetic complex

(a) $[Co(OX)_3]^{3-}$, $[Fe(CN)_6]^{4-}$
(b) $[Co(Ox)_3]^{3-}$, $[FeF_6]^{3-}$
(c) $[Fe(OX)_3]^{3-}$, $[FeF_6]^{3-}$
(d) $[Fe(CN)_6]^{3-}$, $[CoF_6]^{3-}$

25. Which of the following can be reduce easily

(a) $V(CO)_6$
(b) $Mo(CO)_6$
(c) $[Co(CO)_4]^-$
(d) $Fe(CO)_5$

26. Cr^{+3} in aquous medium form green coloured complex with NH_3 ligand. How many ligand associated

(a) 3
(b) 4
(c) 5
(d) 6

27. The oxidation state of Cr in $[Cr(NH_3)_4Cl_2]^+$ is :

(a) 0
(b) +1
(c) +2
(d) +3

28. Which of the following will show optical isomerism ?

(a) $[Cu(NH_3)_4]^{2+}$
(b) $[ZnCl_4]^{2-}$
(c) $[Cr(C_2O_4)_3]^{3-}$
(d) $[Co(CN)_6]^{3-}$

29. The value of 'spin only' magnetic moment for one of the following configurations is 2.84 BM. The correct one is:

(a) d^4 (in strong field ligand)
(b) d^4 (in weak field ligand)
(c) d^3 (in weak as well as strong field ligand)
(d) d^5 (in strong field ligand)

30. In $Fe(CO)_5$, the Fe – C bond possesses :

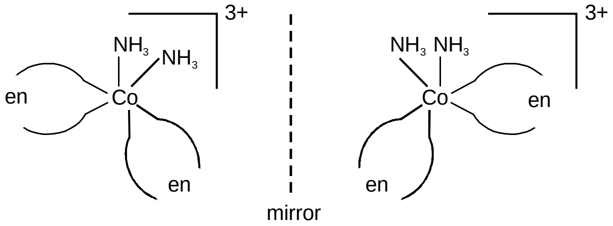
(a) π-character only
(b) both σ and π characters
(c) ionic character only
(d) σ-character only

1. **(b)**

$4K^+[Ni(CN)_4]^{4-}$; let the oxidation state of nickel is x, then $x + 4(-1) = -4$

So, $x = 0$

2. **(c)**



cis-form of $[Co(en)_2(NH_2)]^{3+}$ has optical isomers.

3. **(a)**

Mole of $CoCl_3 \cdot 6NH_3 = \dfrac{2.675}{267.5} = 0.01$

$AgNO_3\,(aq) + Cl^-\,(aq) \xrightarrow{\quad} AgCl^-$ (white)

Mole of $AgCl = \dfrac{4.78}{143.5} = 0.03$

0.01 mole of $CoCl_3 \cdot 6NH_3$ gives 0.03 mole of AgCl

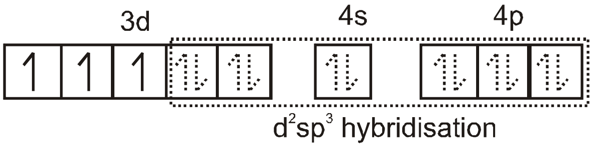
1 mole of $CoCl_3 \cdot 6NH_3$ ionises to give 3 moles of Cl^-.

Hence the formula of compound is $[Co(NH_3)_6]Cl_3$.

4. **(c)**

In case of d^3 configuration, the number of unpaired electrons remains 3 whether the ligand is strong field or weak field. The hybridisation scheme can be shown as follow :

$[Cr(NH_3)_3]^{3+}$ =



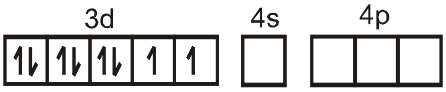
Hence the complex is inner orbital complex as it involves (n – 1) d orbitals for hybridisation,

$3.93 = \sqrt{n(n+2)}$; so n = 3 (here n is number of unpaired electron(s)).

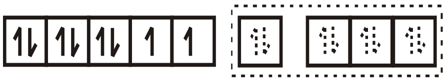
5. (c)

In the paramagnetic and tetrahedral complex $[NiCl_4]^{2-}$, the nickel is in +2 oxidation state and the ion has the electronic configuration $3d^8$. The hybridisation scheme is as shown in figure.

Ni^{2+}, $[Ar]3d^8$



$[NICL_4]^{2-}$



SP^3 HYBRID ORBITALS

$\mu_{B.M.} = \sqrt{n(n+2)} = \sqrt{2(2+2)} = \sqrt{8} = 2.82$ BM

6. **(d)**

(i) The central atom, Co is placed first.

(ii) The ligands are then placed in alphabetical order.

(iii) The formula for the entire coordination entity, whether charged or not, is enclosed in square brackets.

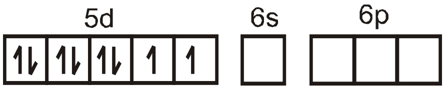
7. (c)

(C) $[Co(NH_3)_5(NO_2)]Cl_2 \overset{aq.}{\rightleftharpoons} [Co(NH_3)_5(NO_2)]^{2+}$ (aq) + $2Cl^-$(aq) (no. of ions = 3)

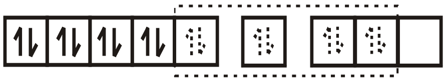
$2Ag^+ + 2Cl^- \longrightarrow 2AgCl \downarrow$ (white).

8. (a)

$5d^8$ configuration have higher CFSE and the complex is thus square planar and diamagnetic.
Pt^{2+}, $[Xe]4f^{14}\,5d^8$



$[Pt(NH_3)_4]^{2-}$



dsp^2 hybrid orbitals

9. (d)

$(C_2H_5)_4$ Pb is a σ-bonded complex.

10. (d)

Ferrocene, Fe $(\eta^5 - C_5H_5)_2$
is bis(cyclopentadienyl)iron(II)

11. (b)

(B) Exhibits linkage isomerism as it has ambidentate ligand, NO_2^-.

12. (d)

$[Mn(H_2O)_6]^{2+} = 3 \times (-0.4) + 2 \times (0.6) = 0$

$[Cr(H_2O)_6]^{2+} = 3 \times (-0.4) + 1 \times (0.6) = 0.6\ \Delta_0$

$[Mn(H_2O)_6]^{3+} = 3 \times (-0.4) + 1 \times (0.6) = 0.6\ \Delta_0$

$[Cr(H_2O)_6]^{3+} = 3 \times (-0.4) + 0 \times (0.6) = 1.2\ \Delta_0$

13. (b)

A square planar complex results from dsp^2-hybridisation involving $(n-1)d_{x^2-y^2}$, ns, np_x and np_y atomic orbitals.

14. (d)

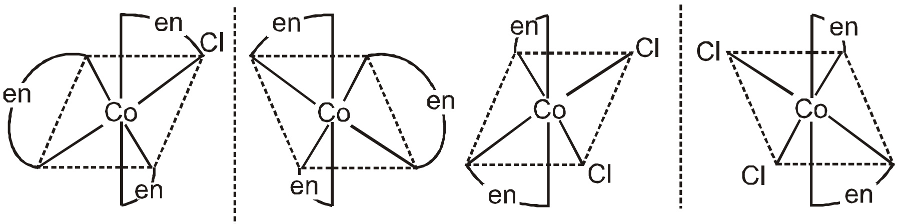
(A) $[Fe(CN)_6]^{4-}$ d^6 CN^- is strong field ligand.

(B) $[Ni(CO)_4]$ d^{10} CO is strong field ligand.

(C) $[Ni(CN)_4]^{2-}$; Ni^{2+} has $3d^8$ configuration and CN^- is strong field ligand. So, complex is square planar and diamagnetic.

(D) $[CoF_6]^{3-} d^6 F^-$ being weak field ligand does not allow pairing.

15. (b)



$[Co(en)_3]^{3+}$ cis-$[Co(en)_2Cl_2]^+$

16. (a) As all are octahedral complexes of the same metal(Ni), absorption will depend only on the nature of the ligand. From spectrochemical series, the CFSE of the given ligands are in the order : $H_2O < NH_3 < NO_2^-$

Hence, excitation energies absorbed to show particular colour will be in the order :

$[Ni(H_2O)_6]^{2+} < [Ni(NH_3)_6]^{2+} < [Ni(NO_2)_6]^{4-}$

The wavelength absorbed will be in the opposite order.

17. (b) Since the precipitate of AgCI shows two ionisable chloride ion the complex must have the structure.

$[Co(NH_3)_5CI]CI_2 + 2AgNO_3 \rightarrow [Co(NH_3)_5CI](NO_3)_2 + 2AgCI$ Hence two chlorine atoms satisfy the primary valency and one, secondary valency.

18. (a) The complex chlorodiaquatriammine cobalt (III) chloride can have the structure $[CoCl(NH_3)_3(H_2O)_2]Cl_2$.

19. (b)

20. (d)

21. (c) $[Co(NH_3)_5SO_4]\,Br + AgNO_3 \longrightarrow [Co(NH_3)_5SO_4] +$

AgBr

0.02 mole

(Y)

$[Co(NH_3)_5Br]\,SO_4 + BaCl_2 \longrightarrow [Co(NH_3)_5Br]\,Cl_2 +$

$BaSO_4$

$\frac{0.02}{2}\,molL^{-1}$

(Z)

$0.01\ molL^{-1}$

22. (d)

23. (b)

24. (a) Diamagnetic complex is are

$[Co(Ox)_3]^{3-}$ and $\left[Fe(CN)_6\right]^{3-}$

25. (a) $V(CO)_6$ easily reduces to $\left[V(CO)_6\right]^-$

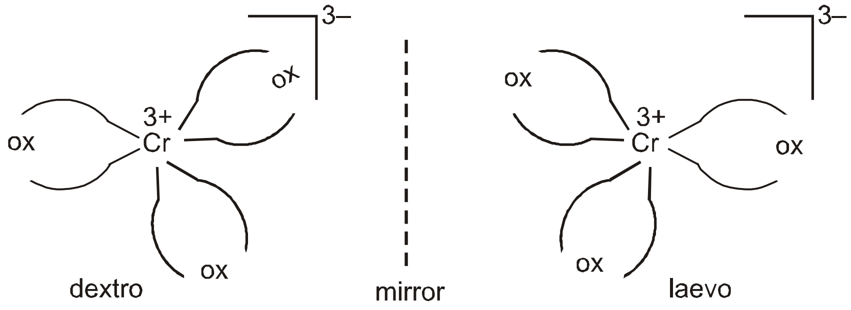
26. (d) $[Cr(H_2O)_6]^{+3} + 6NH_3 \longrightarrow [Cr(NH_3)_6]^{+3} = + 6H_2O$

Cr^{+3} show six C.N. with NH_3

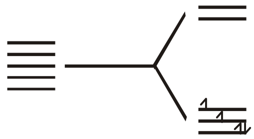
27. (d) $[Cr(NH_3)_4Cl_2]^+$; let the oxidation state of Cr is x, then x + 4 (–0) + 2 (–1) = +1

So, x = 3

28. (c) Due to the absence of symmetry elements it shows optical isomerism.



29. (a)$3d^4$



CN^- is strong field ligand ; so it compels for pairing of electrons to have two d-orbital empty.

$$\mu = \sqrt{n(n+2)} = \sqrt{2(2+2)} = 2.84 \text{ B.M}$$

30. (b) Metal-carbon bond in metal carbonyls has σ as well as π characters.