	INDIAN SCHOOL AL WADI AL KABIR	
Class: XII	**Department: SCIENCE 2024 - 25** **SUBJECT: CHEMISTRY**	**Date of submission:** **17.11.2024**
Worksheet No: 10 **WS WITH ANS.**	**Chapter: 5 - Coordination Compounds**	**Note:** **A4 FILE FORMAT**
CLASS & SEC:	**NAME OF THE STUDENT**	**ROLL NO.**

Q. No.	Questions and Answers	Marks
1.	Name the following complex compounds or ions. 1. $[Al(H_2O)_6]Br_3$ **Hexaaquaaluminium(III) bromide** 2. $[Cr(NH_3)_6]Cl_3$ **Hexaamminechromium (III) chloride** 3. $K_3[FeF_6]$ **Potassium hexafluoridoferrate(III)** 4. $[Zn(OH)_4]^{-2}$ **Tetrahydroxidozincate(II) ion** 5. $[Co(H_2O)_4Cl_2]Cl$ **Tetraaquadichlorido(III) chloride** 6. $[Cu(NH_3)_4]^{+2}$ **Tetraamminecopper (II) ion** 7. $K_2[SnCl_6]$ **Potassium hexachloridostannate(IV)** 8. $[Pt(NH_3)_4Cl_2][PtCl_6]$ **Tetraamminedichloridoplatinum(IV) hexachloridoplatinate(IV)**	1 each
2.	Write the formula for each of the following complex compounds or ions. 1. Hexaamminecobalt (III) chloride **$[Co(NH_3)_6]Cl_3$** 2. **Diamminetetrabromidoplatinum(VI) bromide** **$[Pt(NH_3)_2Br_4]Br_2$** 3. Tetraaquacadmium (II) nitrate **$[Cd(H_2O)_4](NO_3)_2$** 4. Diamminesilver (I) ion **$[Ag(NH_3)_2]^+$** 5. **Sodium tetracyanidocuprate(I)** **$Na_3[Cu(CN)_4]$** 6. **Silver hexacyanidoferrate(II)** **$Ag_4[Fe(CN)_6]$** 7. Tetraammineoxalatonickel (II) **$[Ni(NH_3)_4C_2O_4]$**	1 each

3.	**Identify the denticity of the ligands given below:** aqua H_2O monodentate ammine NH_3 monodentate benzene C_6H_6 monodentate (sometimes hexadentate) carbonyl CO monodentate nitrosyl NO monodentate methylamine CH_3NH_2 monodentate dimethylamine $(CH_3)_2NH_2$ monodentate trimethylamine $N(CH_3)_3$ monodentate ethylenediamine or en $H_2NCH_2CH_2NH_2$ bidentate diethylenediamine or dien $NH(CH_2CH_2NH_2)_2$ tridentate triethylenetetraamine or trien $N(CH_2CH_2NH_2)_3$ tetradentate Pyridine or py C_5H_5N monodentate trimethylphosphine (PMe3) $P(CH_3)_3$ monodentate	1 each
4.	**Identify the geometry of the given complexes:** 	CN	Geometry	Hybridization	Example
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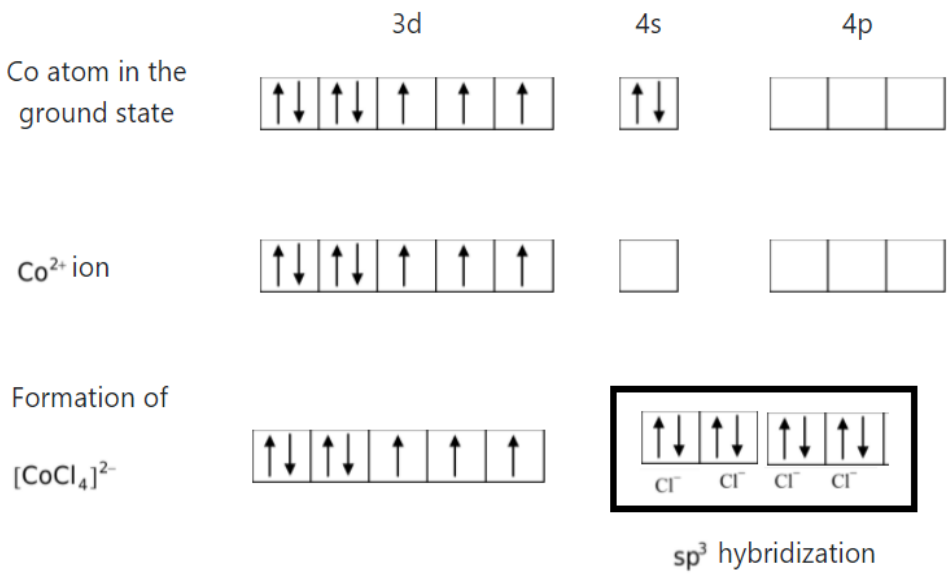
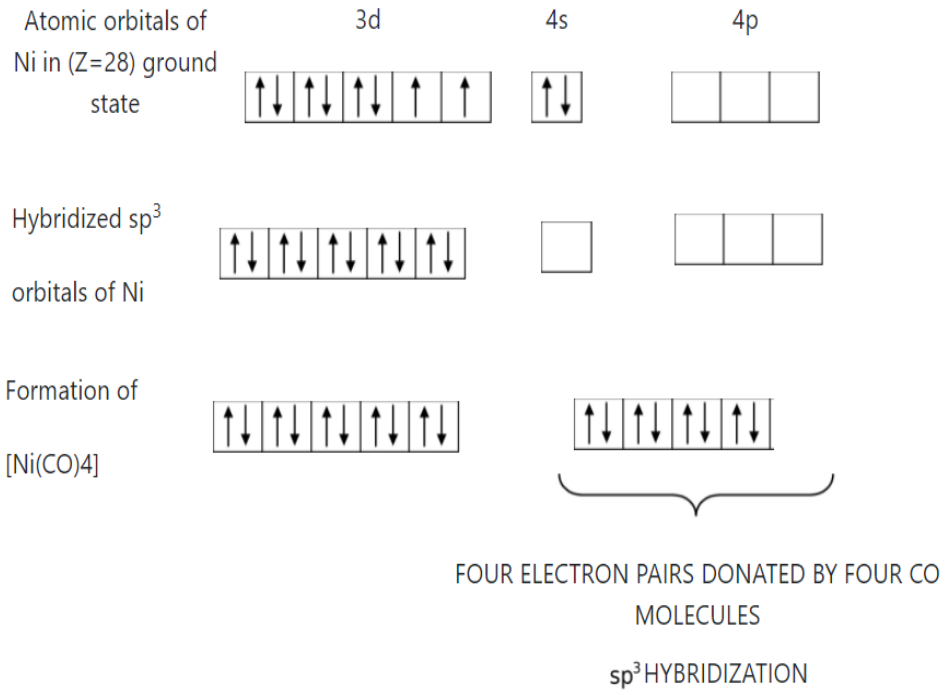
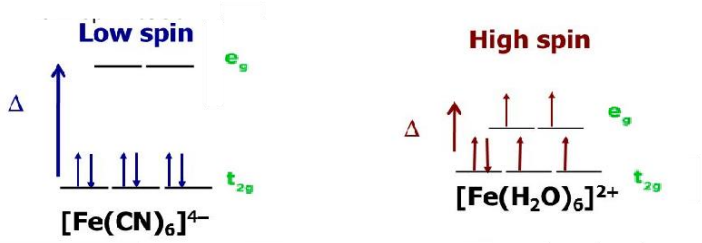
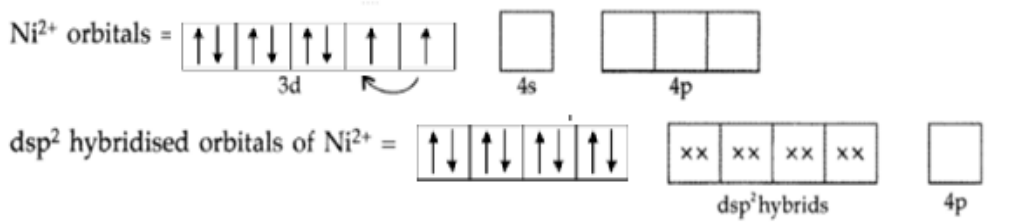
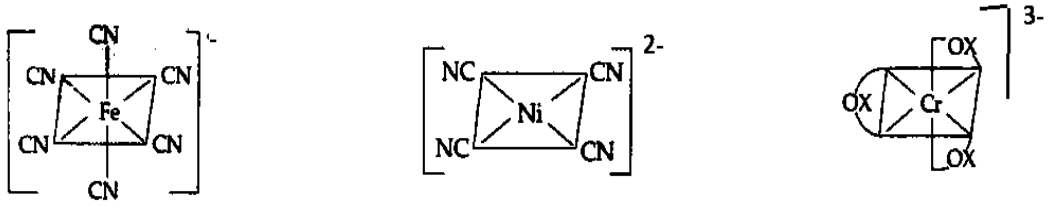
2	Linear	sp	$[Ag(NH_3)_2]^+$
4	Tetrahedral	sp^3	$[Cd(NH_3)_4]^{2+}$
4	square planar	sp^2d	$[Cu(OH_2)_4]^{2+}$
5	trigonal bipyramid	sp^3d	$Fe(CO)_5$
5	Square pyramidal	sp^2d^2	$[MnCl_5]^{3-}$
6	Octahedral	sp^3d^2	$[Fe(CN)_6]^{4-}$		1 each

5.	**Show the:** **Formation of $[CoCl_4]^{2-}$**  	2 each
6.	Show the: **Formation of $[Ni(CO)_4]$**:  	2 each

7.	**Compare the two complexes based on CFT:**  	1 each
8.	Give IUPAC name of $[Ni(NH_3)_3NO_3]Cl$. IUPAC name : Triamminenitratonickel (III) chloride	1 each
9.	Give two examples of ligands which form coordination compounds useful in analytical chemistry. (i) EDTA (Ethylene diamine tetra-acetic acid) (ii) Dimethyl glyoxime (DMG)	1 each
10.	Which of the following is more stable complex and why? $[Co(NH_3)_6]^{3+}$ and $[Co(en)_3]^{3+}$ $[Co(en)_3]^{3+}$ is more stable complex than $[CO(NH_3)_6]^{3+}$ because of chelate effect.	1 each
11.	**List down the properties of:** $[Ni(CN)_4]^{2-}$  Containing 4 pairs of electrons from 4 CN molecules ***Shape :*** Square planar ***Hybridisation :*** dsp^2 ***Magnetic behaviour :*** Diamagnetic (no unpaired electrons)	
12.	**What are the factors affecting the stability of the complexes?** Factors affecting the stability of a complex ion (i) Nature of metal ion: The greater the charge and the smaller the ion's size, the higher its charge density, and the greater the complex's stability.	1 each

	(ii) Nature of ligand: The more the basicity of the ligand, the more its tendency to donate electron pair and therefore, more the stability of the complex.	
13.	**When a coordination compound $CoCl_3.6NH_3$ is mixed with $AgNO_3$, 3 moles of AgCl are precipitated per mole of the compound.** **Write** **(i) Structural formula of the complex** **(ii) IUPAC name of the complex .** (i) Complex so formed is: $CoCl_3.6NH_3 + AgNO_3 \rightarrow [Co(NH_3)_6]Cl_3$ (ii) IUPAC name of the complex is: Hexaamminecobalt (III) chloride	1 each
14.	**Using IUPAC norms write the formulae for the following:** **(a) Potassium trioxalatoaluminate (III)** **(b) Dichloridobis(ethane-l, 2-diamine) cobalt (III) ion** (a) $K_3[Al(C_2O_4)_3]$ (b) $[Co(Cl)_2(en)_2]^+$	1 each
15.	**For the complex $[Fe(en)_2Cl_2]$, Cl, (en = ethylene diamine), identify** **(i) the oxidation number of iron,** **(ii) the hybrid orbitals and the shape of the complex,** (i) $[Fe(en)_2Cl_2]$ Cl or $x + 0 + 2(-1) + (-1) = 0$ $x + (-3) = 0$ or $x = +3$ ∴ Oxidation number of iron, $x = +3$ (ii) The complex has two bidentate ligands and two monodentate ligands. Therefore, the coordination number is 6 and hybridization will be d^2sp^3 and shape will be octahedral.	1 each
16	**Explain the following terms giving a suitable example in each case :** **(i) Ambidentate ligand** **(ii) Denticity of a ligand** **(iii) Crystal field splitting in an octahedral field (All India 2011)** **(i) Ambidentate ligand**: The monodentate ligands with more than one coordinating atoms is known as ambidentate ligand. Monodentate ligands have only one atom capable of binding to a central metal atom or ion. For example, the nitrate ion NO_2^- can bind to the central metal atom/ion at either the nitrogen atom or one of the oxygen atoms. Example : — SCN thiocyanato - S, — NCS thiocyanato-N	

	(ii) Denticity of a ligand: The number of donor atoms in a ligand that forms a coordinate bond with the central metal atom is called denticity of a ligand. Example: If the donor atom is one then it is called a Monodentate ligand, if it is two, then it is called Bidentate, and so on. **(iii) Crystal field splitting:** It is the splitting of the degenerate energy levels due to the presence of ligands. When a ligand approaches a transition metal ion, the degenerate d-orbitals split into two sets, one with lower energy and the other with higher energy. This is known as crystal field splitting and the difference between the lower energy set and the higher energy set is known as crystal field splitting energy (CFSE)	
17	**State a reason for each of the following situations :** **(i) Co^{2+} is easily oxidized to Co^{3+} in the presence of a strong ligand.** **(ii) CO is a stronger complexing reagent than NH_3.** **(iii) The molecular shape of $[Ni(CO)_4]$ is not the same as that of $[Ni(CN)_4]^{2-}$ (Delhi 2011)** (i) Because in the presence of strong ligands, the crystal field splitting energy is more than the energy required to oxidise Co^{2+}. (ii) This is due to the formation of π – bond by back donation of electrons from metal to carbon of CO or due to synergic bonding. (iii) CO is a stronger field ligand than CN. Ni is in zero oxidation state in $Ni(CO)_4$ and has tetrahedral geometry. But, Ni is in +2 oxidation state in $[Ni(CN)_4]^{2-}$ and has dsp^2 hybridization (different geometry than tetrahedral sp^3).	1 each
18.	**Draw the geometry of the various complexes.** $[Fe(CN)_6]^{4-}$ **$[Ni(CN)_4]^{2-}$** $[Cr(C_2O_4)_3]^{3-}$ 	1 each
19.	**Compare the CFT of tetrahedral complexes and octahedral complexes.** • In tetrahedral coordination entity formation, the d orbital splitting is inverted and is smaller than the octahedral field splitting.	any 2 points - 2 marks

	• For the same metal, the same ligands, and metal-ligand distances, it can be shown that: $\Delta_t = (4/9)\ \Delta_0$ • Consequently, the orbital splitting energies are not sufficiently large for forcing pairing; therefore, low spin configurations are rarely observed. • **The 'g' subscript is used for the octahedral and square planar complexes which have the center of symmetry. Since tetrahedral complexes lack symmetry, the 'g' subscript is not used with energy levels.**	
20.	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 **Ans: Option (ii)**	1
21	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) $[Co(CN)_6]^{3-} > [Co(NH_3)_6]^{3+} > [Co(H_2O)_6]^{3+}$ **Ans. Option (iii)**	1
22	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) $[Fe(H_2O)_6]^{3+}$ **Ans. Option (iii)**	1

23	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} **Ans. Option (iii)**	1
24	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 **Ans. Option (i)**	1
25	Match the coordination compounds given in Column I with the central metal atoms given in Column II and assign the correct code : **Column I (Coordination Compound)** / **Column II (Central metal atom)** A. Chlorophyll — 1. rhodium B. Blood pigment — 2. cobalt C. Wilkinson catalyst — 3. calcium D. Vitamin B_{12} — 4. iron 5. magnesium Code : (i) A (5) B (4) C (1) D (2) (ii) A (3) B (4) C (5) D (1) (iii) A (4) B (3) C (2) D (1) (iv) A (3) B (4) C (1) D (2) **Ans. Option (i)**	1
26	In the following questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices. (i) Assertion and reason both are true; reason is the correct explanation of assertion. (ii) Assertion and reason both are true but reason is not the correct explanation of assertion. (iii) Assertion is true, reason is false. (iv) Assertion is false, reason is true.	

a. b. c. d. e.	**Assertion** : Toxic metal ions are removed by the chelating ligands. **Reason** : Chelate complexes tend to be more stable. **Assertion** : $[Cr(H_2O)_6]Cl_2$ and $[Fe(H_2O)_6]Cl_2$ are reducing in nature. **Reason** : Unpaired electrons are present in their *d*-orbitals. **Assertion** : Linkage isomerism arises in coordination compounds containing ambidentate ligand. **Reason** : Ambidentate ligand has two different donor atoms. **Assertion** : Complexes of MX_6 and MX_5L type (X and L are unidentate) do not show geometrical isomerism. **Reason** : Geometrical isomerism is not shown by complexes of coordination number 6. **Assertion** : $([Fe(CN)_6]^{3-}$ ion shows magnetic moment corresponding to two unpaired electrons. **Reason** : Because it has d^2sp^3 type hybridisation. **Ans.** **a. i** **b. ii** **c. i** **d. ii** **e. iv**	1 each
27	$CoSO_4Cl.5NH_3$ exists in two isomeric forms 'A' and 'B'. Isomer 'A' reacts with $AgNO_3$ to give white precipitate, but does not react with $BaCl_2$. Isomer 'B' gives white precipitate with $BaCl_2$ but does not react with $AgNO_3$. Answer the following questions. (i) Identify 'A' and 'B' and write their structural formulas. (ii) Name the type of isomerism involved. (iii) Give the IUPAC name of 'A' and 'B'. **Ans.** (i) A - $[Co(NH_3)_5SO_4]Cl$ B - $[Co(NH_3)_5Cl]SO_4$ (ii) Ionisation isomerism (iii) (A), Pentaamminesulphatocobalt (III) chloride (B), Pentaamminechloridocobalt(III) sulphate	5

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