INDIAN SCHOOL AL WADI AL KABIR		
Class: XII	**DEPARTMENT: SCIENCE (2026-27)** **SUBJECT: CHEMISTRY**	**Date: 05/11/2026**
Worksheet: 10	**TOPIC: COORDINATION COMPOUNDS**	**Note:** **A4 FILE FORMAT**
CLASS & SEC:	**NAME OF THE STUDENT:**	**ROLL NO.**

MULTIPLE CHOICE QUESTIONS (1M)

1. Which of the following best explains the chelate effect?
   (A) Chelating ligands always have a higher molecular mass.
   (B) Complexes containing multidentate ligands are more stable than those containing monodentate ligands.
   (C) Chelating ligands donate fewer electrons to the metal ion.
   (D) Chelating ligands reduce the oxidation state of the metal ion.

2. How many ions are produced in the solution from the complex $[Ni(NH_3)_6]Cl_2$?
   (A) 4 (B) 3 (C) 2 (D) 5

3. Write the coordination number and oxidation state of Platinum in the complex $[Pt(en)_2Cl_2]$ 2018
   (A) Coordination number – 4, Oxidation state – 2
   (B) Coordination number – 4, Oxidation state – 4
   (C) Coordination number – 6, Oxidation state – 0
   (D) Coordination number – 6, Oxidation state – 2

4. Which of the following is the most stable complex species? 2023
   (A) $[Fe(C_2O_4)_3]^{3-}$ (B) $[Fe(CN)_6]^{3-}$
   (C) $[Fe(CO)_5]$ (D) $[Fe(H_2O)_6]^{3+}$

5. Number of possible stereoisomers for the complex $[Co(en)_2Cl_2]Cl$ will be: 2026
   (A) 3 (B) 4
   (C) 2 (D) 1

6. Which of the following d orbitals experience more repulsion in the crystal field splitting of tetrahedral complexes? 2026
   (A) $d_{x^2-y^2}, d_{z^2}$ (B) $d_{x^2-y^2}, d_{xy}$
   (C) d_{xy}, d_{yz}, d_{z^2} (D) d_{xy}, d_{yz}, d_{xz}

7. Write the formula of Wilkinson's catalyst.:
   (A) $[(Ph_3P)_3RhCl]$ (B) $Pd\text{-}BaSO_4$
   (C) $[Ag(CN)_2]^-$ (D) $[Cl_3Rh(Ph_3P)]$

8. Arrange the following complexes in the increasing order of conductivity of their solution.

(A) $[Cr(NH_3)_3Cl_3] < [Cr(NH_3)_6]Cl_3 < [Cr(NH_3)_5Cl]Cl_2$
(B) $[Cr(NH_3)_3Cl_3] < [Cr(NH_3)_5Cl]Cl_2 < [Cr(NH_3)_6]Cl_3$
(C) $[Cr(NH_3)_6]Cl_3 < [Cr(NH_3)_5Cl]Cl_2\ [Cr(NH_3)_3Cl_3]$
(D) $[Cr(NH_3)_5Cl]Cl_2 < [Cr(NH_3)_6]Cl_3 < [Cr(NH_3)_3Cl_3]$

9. The IUPAC name of $K_4[Mn(CN)_6]$ and the electronic configuration in terms of t_2g and e_g are:

(A) Potassium hexacyanidomanganate(II); $t_2g^5e_g^0$
(B) Potassium hexacyanidomanganate(II); $t_2g^6e_g^0$
(C) Potassium hexacyanidomanganate(III); $t_2g^4e_g^0$
(D) Potassium hexacyanidomanganate(III); $t_2g^5e_g^0$

10. Which of the following is true for $[Ni(CN)_4]^{2-}$?

(A) sp^3 hybridisation and paramagnetic nature
(B) dsp^2 hybridisation and diamagnetic nature
(C) sp^3d hybridisation and diamagnetic nature
(D) d^2sp^3 hybridisation and paramagnetic nature

ASSERTION REASON TYPE QUESTIONS (1M)

(A) Both (A) and (R) are true, and (R) is the correct explanation of (A).

(B) Both (A) and (R) are true, and (R) is not the correct explanation of (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

11. **Assertion (A):** Low-spin tetrahedral complexes are rarely observed
Reason (R): The orbital splitting energies are not sufficiently large to force pairing.

12. **Assertion(A):** $[Co(NH_3)_6]^{3+}$ is an inner orbital complex.
Reason(R): NH_3 is a unidentate ligand.

13. **Assertion (A):** Trans $[CrCl_2(ox)_2]^{3-}$ shows optical isomerism.
Reason (R): Optical isomerism is common in octahedral complexes involving didentate ligands.

14. **Assertion (A):** $[Fe(CN)_6]^{3-}$ ion shows a magnetic moment corresponding to one unpaired electron.
Reason (R): $[Fe(CN)_6]^{3-}$ has sp^3d^2 hybridisation.

15. **Assertion (A):** $[Co(NH_3)_4Cl_2]^+$ is a heteroleptic complex
Reason (R): A heteroleptic complex consists of unidentate ligands only.

16. **Assertion(A):** The complex $K_3[Cr(C_2O_4)_3]$, when present in aqueous solution, will give a positive test for K^+ ions but not for Cr^{3+} ions.
Reason(R): The complex $K_3[Cr(C_2O_4)_3]$, dissociates completely in aqueous solution.

SHORT ANSWER TYPE QUESTIONS (2M)

17. (a) When a coordination compound $NiCl_2.6H_2O$ is mixed with $AgNO_3$ solution, 2 moles of AgCl are precipitated per mole of the compound. Write the structural formula of the complex and secondary valency for Nickel ion.
(b) Write the IUPAC name of the ionisation isomer of $[Co(NH_3)_5(SO_4)]Cl$ (2023)

18. (a) How many geometrical isomers are possible in each of the following complexes?
(I) $[Cr(C_2O_4)_3]^{3-}$ (II) $[Co(NH_3)_3Cl_3]$
(b) $[Co(NH_3)_6]^{3+}$ is an inner orbital complex whereas $[Ni(NH_3)_6]^{2+}$ is an outer orbital complex. Why?
[Atomic number: Co = 27, Ni = 28] (2026)

19. Write the formulae for the following coordination compounds:
(a) Mercury(I) tetrathiocyanato-S-cobaltate(III)
(b) Dichloridobis(ethane-1,2-diamine)platinum(IV) nitrate

20. Write two differences between primary and secondary valences in coordination compounds. (2024)

21. For a d^4 ion, write the configuration if (i) $\Delta_o < P$ and (ii) $\Delta_o > P$

SHORT ANSWER TYPE QUESTIONS (3M)

22. (a) Write the IUPAC name of the complex $[Co(NH_3)_5(ONO)]^{2+}$.
(b) Write the hybridisation and predict the magnetic behaviour of $[Ni(CN)_4]^{2-}$ (Atomic number: Ni=28)
(c) What type of isomerism is shown by the given complex:
$[Co(NH_3)_6][Cr(CN)_6]$ (2026

23. Give reasons for the following.
(a) Geometrical isomerism is not possible in tetrahedral complexes having two different types of unidentate ligands coordinated with the central metal ion.
(b) $[Mn(CN)_6]^{3-}$ has a magnetic moment of two unpaired electrons, while $[MnCl_6]^{3-}$ has a paramagnetic moment of four unpaired electrons.
(c) Anhydrous $CuSO_4$ is white, but $CuSO_4 .5H_2O$ is blue in colour.

24. (a) Predict the number of unpaired electrons in the square planar $[Pt(CN)_4]^{2-}$ ion.
(b) The hexaquamanganese(II) ion contains five unpaired electrons, while the hexacyanoion contains only one unpaired electron. Explain using the Crystal Field Theory.
(c) $[NiCl_4]^{2-}$ is paramagnetic while $[Ni(CO)_4]$ is diamagnetic, though both are tetrahedral. Why?

25. Give the formula of each of the following coordination entities:
(a) Co^{3+} ion is bound to one Cl^-, one NH_3 molecule and two bidentate ethylene diamine (en) molecules.
(b) Ni^{2+} ion is bound to two water molecules and two oxalate ions.
Write the name and magnetic behaviour of each of the above coordination entities.
(Atomic number: Co=27, Ni=28)

26. Explain the following cases giving appropriate reasons:
(a) Nickel does not form low-spin octahedral complexes.
(b) The π complexes are known for the transition metals only.
(c) $Co^{2+}$is easily oxidised to Co^{3+} in the presence of a strong ligand.

PASSAGE-BASED QUESTIONS (4M)

27. Read the passage and answer the following questions.
One of the most distinctive properties of transition metal complexes is their wide range of colours. This means that some of the visible spectrum is being removed from white light as it passes through the sample, so the light that emerges is no longer white. The colour of the complex is complementary to that which is absorbed. The complementary colour is the colour generated from the wavelength left over. If green light is absorbed by the complex, it appears red. The table given below gives the relationship between different wavelengths of the light absorbed and the colour observed.

Coordination Entity	Wavelength of light absorbed (nm)	Colour of light absorbed	Colour of coordination entity
$[CoCl(NH_3)_5]^{2+}$	535	Yellow	Violet
$[Co(NH_3)_5(H_2O)]^{3+}$	500	Blue-green	Red
$[Co(NH_3)_6]^{3+}$	475	Blue	Yellow-orange
$[Co(CN)_6]^{3-}$	310	Ultra-Violet (U.V.)	Pale Yellow
$[Cu(H_2O)_4]^{2+}$	600	Red	Blue
$[Ti(H_2O)_6]^{3+}$	498	Blue-green	Violet

(a) What is spectrochemical series? Write the relationship between Δ_t and Δ_o.
(b) Why does the complex $[Co(CN)_6]^{3-}$ absorb light of wavelength 310 nm?
(c) Define crystal field splitting energy.

LONG ANSWER TYPE QUESTIONS (5M)

28. Answer the following questions.
(a) Find the oxidation state and coordination number of the central metal ion in $[Co(H_2O)(CN)(en)_2]^{2+}$
(b) Write the IUPAC name of the complex $K_3[Cr(C_2O_4)_3]$
(c) What is the secondary valence of Co in $[Co(NH_3)_4Cl_2]^+$?
(d) What type of isomerism is shown by the complex $[Cr(H_2O)_6]Cl_3$ and $[Cr(H_2O)_5Cl]Cl_2.H_2O$ and explain the isomerism.
(e) What is meant by the chelate effect? How does it affect the stability of the complex?

ANSWERS

Q.NO	ANSWERS	MARKS
1	(B) Complexes containing multidentate ligands are more stable than those containing monodentate ligands.	1
2	(B) 3	1
3	(D) Coordination number – 6, Oxidation state – 2	1
4	(A) $[Fe(C_2O_4)_3]^{3-}$	1
5	(A) 3	1
6	(D) d_{xy}, d_{yz}, d_{xz}	1
7	(A) $[(Ph_3P)_3RhCl]$	1
8	(B) $[Cr(NH_3)_3Cl_3] < [Cr(NH_3)_5Cl]Cl_2 < [Cr(NH_3)_6]Cl_3$	1
9	(A) Potassium hexacyanidomanganate(II); $t_2g^5e_g^0$	1
10	(B) dsp^2 hybridisation and diamagnetic nature	1
11	(A) Both (A) and (R) are true, and (R) is the correct explanation of (A).	1
12	(B) Both (A) and (R) are true, and (R) is not the correct explanation of (A).	1
13	(D) Assertion (A) is false, but Reason (R) is true.	1
14	(C) Assertion (A) is true, but Reason (R) is false.	1
15	(B) Both (A) and (R) are true, and (R) is not the correct explanation of (A).	1
16	(C) Assertion (A) is true, but Reason (R) is false.	1
17	(a) The structural formula of the complex is $[Ni(H_2O)_6]Cl_2$, and the secondary valence of the nickel ion is 6.	½ , ½

	(b) The IUPAC name of the ionisation isomer is Pentaamminechloridocobalt(III) sulphate.	1
18	(a) (I) 0 (II) 2 (b) $[Co(NH_3)_6]^{3+}$ Co^{3+} ($3d^6$) undergoes d^2sp^3 hybridisation. The NH_3 ligand forces electrons to pair up, making two inner 3d orbitals available. $[Ni(NH_3)_6]^{2+}$ Ni^{2+} ($3d^8$) undergoes sp^3d^2hybridisation. The 3d electrons do not pair up. The metal ion uses the higher-energy outer 4d orbitals, undergoing sp^3d^2 hybridisation. Because it utilises the outer 4d orbitals, it is an outer orbital complex.	½ , ½ ½ ½
19	(a) $Hg[Co(SCN)_4]$ (b) $[PtCl_2(en)_2](NO_3)_2$	1 1
20	<table><tr><td>Features</td><td>Primary Valence</td><td>Secondary Valence</td></tr><tr><td>Nature of bonds</td><td>Ionic</td><td>Non-ionic/Coordinate covalent</td></tr><tr><td>Ionisability</td><td>Ionisable and present outside the coordination sphere</td><td>Non-ionisable and directly bound to the metal inside the sphere</td></tr></table>	1 each
21	(i) $\Delta_o < P$ $t_2g^3eg^1$ (ii) $\Delta_o > P$ $t_2g^4eg^0$	1 1
22	(a) Pentaamminenitrito-O-cobalt(III) ion (b) Hybridisation- dsp^2 Magnetic behaviour- Diamagnetic (c) Coordination isomerism	1 1 1
23	(a) Tetrahedral complexes do not show geometrical isomerism because the relative positions of the unidentate ligands attached to the central metal atom are the same with respect to each other. (b) $[Mn(CN)_6]^{3-}$ d^2sp^3 hybridisation, Out of the four unpaired electrons, one gets paired up under the influence of CN^-(strong ligand) $[MnCl_6]^{3-}$ sp^3d^2 hybridisation. The four unpaired electrons do not pair up under the influence of Cl^- (weak ligand) (c) $[Cu(H_2O)_4]SO_4.H_2O$ is coloured due to the presence of H_2O acting as a ligand. The ligand causes splitting of d orbitals, and hence a d-d transition takes place. On heating, H_2O molecules are lost, and hence no colour.	1 ½ ½ 1
24	(a) The given complex has zero unpaired electrons. (b) $[Mn(H_2O)_6]^{2+}$ d^5 configuration. Since H_2O is a weak ligand, Δ_o will be lower, and hence the configuration becomes $t_2g^3e_g^2$. $[Mn(CN)_6]^{4-}$ d^5 configuration. Since CN is a strong ligand, Δ_o will be higher, and hence the configuration becomes $t_2g^5e_g^0$. (c) $[NiCl_4]^{2-}$ - sp^3 hybridised with two unpaired electrons, Ni(II). In the presence	1 ½ ½ ½

	of Cl^-, electrons do not pair. $[Ni(CO)_4]$ – sp^3 hybridised with zero unpaired electrons Ni(0). In the presence of CO, electrons pair.	½
25	(a) $[Co(NH_3)Cl(en)_2]^{2+}$ Amminechloridobis(ethane-1,2-diamine)cobalt(III) ion Diamagnetic (b) $[Ni(H_2O)_2(ox)_2]^{2-}$ Diaquadioxalatonickelate(II) ion Paramagnetic	½ ½ ½ ½ ½ ½
26	(a) Ni(II) has $3d^8$ configuration. Even if pairing takes place in the presence of a strong ligand, it leaves behind only one d orbital; hence, low-spin d^2sp^3 hybridisation is not possible. However, high spin sp^3d^2 hybridisation is possible. (b) Ligands donate a pair of electrons to the vacant d orbital of the metal to form a coordinate covalent bond. The metal donates a pair of electrons to the empty antibonding π* orbital of the ligand to form a π bond. (c) Cobalt(II) has an outer electronic configuration of ($3d^7$). When oxidised to Cobalt(III), it becomes $3d^6$, stable $t_2g^6e_g^{0.}$ Strong ligands cause a large crystal field splitting Δ_o in the d orbitals. The large amount of CFSE released overcomes the ionisation energy needed to remove the third electron, making the oxidation highly favourable thermodynamically.	1 1 1
27	(a) A series in which ligands are arranged in the order of increasing field strength. $\Delta_t = (4/9)\ \Delta_0$ (b) Since CN is a strong field ligand, it causes more splitting and Δ_o becomes high. As a result, light corresponding to low wavelength and high energy is required for the excitation of electrons. (c) The energy difference between the two sets of degenerate orbitals (t_2g and eg) after crystal field splitting is known as crystal field splitting energy.	2 1 1
28	(a) Oxidation state: +3 Coordination number: 6 (b) Potassium trioxalatochromate(III) (c) Secondary valence=6 (d) Solvate isomerism (Hydrate isomerism) **Solvate isomerism** (known as hydrate isomerism when water is involved) is a form of structural isomerism where isomers share the same molecular formula but differ based on whether solvent molecules are directly coordinated to the metal ion or present as free molecules in the crystal lattice. (e) The **chelate effect** is the enhanced stability of a metal complex containing chelating ligands (multidentate ligands) compared to a similar complex with monodentate (single-binding) ligands. It occurs because ligands that attach at multiple points form sturdy, stable ring structures with the metal ion.	1 1 1 ½ ½ ½ ½

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