CT-1Q - Ct’s for practise

Chemistry (SRM Institute of Science and Technology)

SRM

DEPARTMENT OF CHEMISTRY
College of Engineering and Technology
SRM Institute of Science and Technology
Kattankulathur – 603203

Set-1

INTERNAL ASSESSMENT – I (CLA1-T1)

Program: B.Tech	Date: 13-09-2023
Course Code & Title:21CYB101J & Chemistry	Duration: 12:30 – 1:20 PM
Year &Sem: I Year & I Sem	Max. Marks: 25 marks

Part – A (5 x 1 = 5 Marks)

Answer ALL The Questions

1 The magnetic moment of complex ion is 2.83 BM. The complex ion is:

(a) $[V(H_2O)_6]^{3+}$ (b) $[Cr(H_2O)_6]^{3+}$

(c) $[Cu(CN)_4]^{2-}$ (d) $[Mn(Cl)_4]^{2-}$

2 A coordination complex's core atom/ion is also known as

(a) Bronsted-Lowry acid (b) Lewis base

(c) Lewis acid (d) Bronsted-Lowry base

3 A $[M(H_2O)_6]^{2+}$ complex typically absorbs at around 600 nm. It is allowed to react with ammonia to form a new complex $[M(NH_3)_5]^{2+}$ that should have absorption at:

(a) 800 nm (b) 580 nm (c) 620 nm (d) 320 nm

4 Which of the following compound shows optical isomerism?

(a) cis-$[CrCl_3(NH_3)_3]$

(b) cis-$[Co(NH_3)_4Cl_2]^+$

(c) $[Co(en)_3]^{3+}$

(d) trans-$[Co(en)_2Cl_2]^+$

5 The Crystal Field Stabilization Energy (CFSE) and magnetic moment (spin-only) of an octahedral aqua complex of a metal ion (M^{z+}) are $-0.8\ \Delta_0$ and 3.87 BM, respectively. Identify (M^{z+}) :

(a) V^{3+} (b) Cr^{3+} (c) Mn^{4+} (d) Co^{2+}

Part – B (2 x 10 = 20 Marks)

6. a. Explain crystal field splitting of d orbitals with neat, labeled diagram and calculation of CFSE, magnetic moment in case of tetrahedral complexes. (10 Marks)

(OR)

b. i. Draw the crystal field splitting diagrams in case of Ni^{2+} for an octahedral crystal field and a tetrahedral crystal field, labeling the d-orbitals. State below each diagram whether the geometry is consistent with a paramagnetic species. (6 Marks)

ii. Write a short note on spectrochemical series. (4 marks)

7 a. i Describe with suitable examples, the structural isomerism in coordination compounds. (10 Marks)

(OR)

b. i. Explain, why Cu(I) complexes such as CuI tend to be colorless, whereas Cu(II) complexes such as $Cu(NO_3)_2.5H_2O$ are brightly colored. (6 Marks)

ii. Calculate Effective Nuclear Charge (Z_{eff}) for 3d electron of Cu (Z= 29) (4 Marks)

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Part – A (5 x 1 = 5 Marks)

Answer ALL The Questions

1) (a) $[V(H_2O)_6]^{3+}$
2) (c) Lewis acid
3) (b) 580 nm
4) (c) $[Co(en)_3]^{3+}$
5) (d) Co^{2+}

Part – B (2 x 10 = 20 Marks)

6. a. Explain crystal field splitting of d orbitals with neat, labeled diagram and calculation of CFSE, magnetic moment in case of tetrahedral complexes. (10 Marks)

Ans: Crystal Field Splitting Diagram for tetrahedral ligand field- 3 Marks,
Explanation – 3 Marks,
CFSE formula – 2 marks
Magnetic moment – 2 marks

(OR)

b. i. Draw the crystal field splitting diagrams in case of Ni^{2+} for an octahedral crystal field and a tetrahedral crystal field, labeling the d-orbitals. State below each diagram whether the geometry is consistent with a paramagnetic species. (6 Marks)

Ans: Energy level diagram for octahedral crystal field (t_{2g}^6 e_g^2): 2 marks
No. of unpaired electrons (n) = 2: 1 mark
Energy level diagram for tetrahedral crystal field (e_g^4 t_{2g}^4): 2 marks
No. of unpaired electrons (n) = 2: 1 mark

ii. Write a short note on spectrochemical series (4 Marks)

Ans: Definition: 1.5 Mark
Series: 1.5 mark
Explanation: 1 mark (Experimentally obtained series by spectroscopy technique, independent of metal and geometry of complex, incorporate both σ and π bonding)

7 a. i Describe with suitable examples, the structural isomerism in coordination compounds. (10 Marks)

Ans: Ionization isomerism, explanation with example : 2.5 marks
Linkage isomerism, explanation with example : 2.5 marks
Coordination isomerism explanation with example : 2.5 marks
Hydrate isomerism explanation with example : 2.5 marks

(OR)

b. i. Explain, why Cu(I) complexes such as CuI tend to be colorless, whereas Cu(II) complexes such as $Cu(NO_3)_2.5H_2O$ are brightly colored. (6 Marks)

Ans: A coordination compound of the **Cu(I) ion has a d^{10} configuration**, and all the **e_g orbitals are filled**. To excite an electron to a higher level, such as the 4p orbital, photons of very high energy are necessary. This energy corresponds to very short wavelengths in the ultraviolet region of the spectrum. **No visible light is absorbed**, so the eye sees no change, and the compound **appears white or colorless**. A solution containing CuI, for example, is colorless.
On the other hand, octahedral **Cu(II) complexes have a vacancy in the e_g orbitals**, and **electrons can be excited to this level**. The wavelength **(energy) of the light absorbed corresponds to the visible part of the spectrum**, and Cu(II) complexes are almost always **colored—blue, blue-green violet, or yellow**.

ii. Calculate Effective Nuclear Charge (Z_{eff}) for 3d electron of Cu (Z= 29) (4 Marks)

Ans: Electronic configuration : 1 Mark
Formula for σ and Calculation: 1.5 marks
Formula for Z_{eff} and Calculation: 1.5 marks

$$Cu(29) = (1s^2)(2s^2 2p^6)(3s^2 3p^6)(4s^1)(3d^{10})$$

$$\sigma = 9 \times 0.35 + 18 \times 1$$

$$Z_{eff} = Z - \sigma = 29 - 9 \times 0.35 - 18$$

$$Z_{eff} = 11 - 3.15 = 7.85$$

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Set-2

INTERNAL ASSESSMENT – I (CLA1-T1)

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Part – A (5 x 1 = 5 Marks)

Answer ALL The Questions

1 Which of the following complex compound(s) is/are paramagnetic and low spin?

(a) $K_3[Fe(CN)_6]$ (b) $[Ni(CO)_4]^0$

(c) $[Cr(NH_3)_6]^{3+}$ (d) $[Mn(CN)_6]^{4-}$

2 An aqueous solution of Ni^{2+} contains $[Ni(H_2O)_6]^{2+}$ and its magnetic moment is 2.83 BM. When ammonia is added in it the magnetic moment of solution

(a) will remain the same (b) will increase from 2.83 BM

(c) will decrease from 2.83 BM (d) cannot be predicted theoretically.

3 Which of the following is true about the complex $[PtCl_2(H_2O)(NH_3)]$?

(a) It's geometry is tetrahedral (b) It is paramagnetic complex

(c) It exhibits geometrical isomerism (d) Pt is sp^3 hybridized

4 $[Fe(H_2O)_6]^{2+}$ and $[Fe(CN)_6]^{4-}$ differ in:

(a) Geometry and magnetic moment (b) Geometry and hybridization

(c) Magnetic moment and color (d) Hybridization and number of d electrons

5 The electronic configuration of metal atom/ionic octahedral complex with d^4 configuration, if $\Delta_o <$ pairing energy is:

(a) $t_{2g}^4 e_g^0$ (b) $e_g^4 t_{2g}^0$ (c) $t_{2g}^3 e_g^1$ (d) $e_g^2 t_{2g}^2$

Part – B (2 x 10 = 20 Marks)

6. a. i. What are different types of isomerism in coordination compounds? Describe geometrical and optical isomerism with suitable examples. *(10 Marks)*

(OR)

b. i. Explain, why the transition metal coordination compounds with strong field ligands are yellow, orange or red in color, whereas with weak field ligands they are often blue-green, blue or indigo in color. *(5 Marks)*

ii. Draw structures for linkage isomers of $[Co(NH_3)_5NO_2]Cl_2$ and optical isomers of $[CoCl_2(en)_2]^+$. *(5 Marks)*

7 a. Calculate CFSE values in terms of Δ_o and P for high spin and low spin octahedral complexes of Fe(II) and Co(II). Predict whether the complexes are paramagnetic or diamagnetic. (10 Marks)

(OR)

b. i. Explain the factors affecting crystal field splitting with suitable examples.

(6 Marks)

ii. Calculate the effective nuclear charge of a electron in 3p orbital of Aluminium atom (Atomic number of Al = 13) (4 Marks)

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ANSWER KEY-Internal Assessment – I

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Answer ALL The Questions **Part – A (5 x 1 = 5 Marks)**

1. (a) $K_3[Fe(CN)_6]$ and (d) $[Mn(CN)_6]^{4-}$
2. (a) will remain the same
3. (c) It exhibits geometrical isomerism
4. (c) Magnetic moment and colour
5. (c) $t_{2g}^3 e_g^1$

Part – B (2 x 10 = 20 Marks)

6. a. i. What are different types of isomerism in coordination compounds? Describe geometrical and optical isomerism with suitable examples. (10 Marks)

Ans: Types of isomerism flow chart: 2 marks
Geometrical isomerism in square planar and octahedral complexes, explanation with examples: 4 marks
Optical isomerism explanation with examples: 4 marks

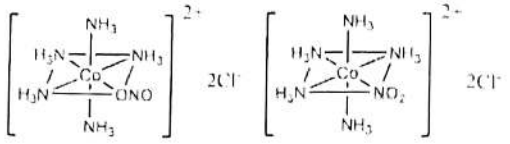
(OR)

b. i. Explain, why the transition metal coordination compounds with strong field ligands are yellow, orange or red in color, whereas with weak field ligands they are often blue-green, blue or indigo in color. (5 Marks)

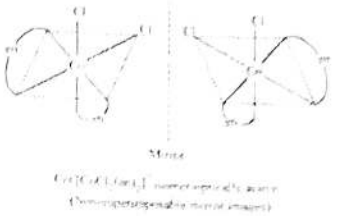
Ans: In general, **strong-field ligands** cause a large split in the energies of d orbitals of the central metal atom (**large Δ_{oct}**). Transition metal coordination compounds with these ligands **absorb higher-energy violet or blue light and hence are often yellow, orange, or red in colour. (2.5 marks)**
On the other hand, coordination compounds of transition metals **with weak-field ligands cause low** split in the energies of d orbitals of the central metal atom (**small Δ_{oct}**). Transition metal coordination compounds with these ligands **absorb lower-energy yellow, orange, or red light and are often blue-green, blue, or indigo** in colour. **(2.5 marks)**

ii. Draw structures for linkage isomers of $[Co(NH_3)_5NO_2]Cl_2$ and optical isomers of $[CoCl_2(en)_2]^+$. (5 Marks)

2.5 Marks



2.5 Marks



7 a. Calculate CFSE values in terms of Δ_o and P for high spin and low spin octahedral complexes of Fe(II) and Co(II). Predict whether the complexes are paramagnetic or diamagnetic. (10 Marks)

Ans:

Fe(II) $-d^6$ configuration **(2.5 marks)**	
Low spin: CFSE = -2.4 Δ_o + 3P n = 0, diamagnetic	**High spin:** CFSE = -0.4 Δ_o + 1P n = 4, paramagnetic, Magnetic moment μ_s = 4.9 BM
Co(II) $-d^7$ configuration **(2.5 marks)**	
Low spin: CFSE = -1.8 Δ_o + 3P n = 1, paramagnetic Magnetic moment μ_s = 1.73	**High spin:** CFSE = -0.8 Δ_o + 2P n = 3, paramagnetic, Magnetic moment μ_s = 3.8 BM

(OR)

b. i. Explain the factors affecting crystal field splitting with suitable examples. (6 Marks)

Ans: Any three factors with examples: each 2 marks

ii. Calculate the effective nuclear charge of a electron in 3p orbital of Aluminium atom (Atomic number of Al = 13) (4 Marks)

Electronic configuration : 1 Mark
Formula for σ and Calculation: 1.5 marks
Formula for Z_{eff} and Calculation: 1.5 marks