

Part – A (5 x 1 = 5 Marks)

Answer ALL The Questions

- 1 The non-axial d-orbitals are
(b) d_{xy} and d_{xz}
- 2 The electronic transition of octahedral $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ is
(a) d-d transition
- 3 The CFSE for d^3 configuration of the central metal ion in tetrahedral complex is
(c) $-0.36 \Delta_o$
- 4 Between these two complexes $\text{Ni}(\text{CO})_4$ and $[\text{Ni}(\text{CN})_4]^{2-}$ which of the following statement is correct
(d) have tetrahedral and square planar geometry respectively
- 5 The magnetic moment of strong field chromium (III) octahedral complex is
(d) 3.87 BM

Part – B (2 x 10 = 20 Marks)

6. a. Discuss spectrochemical series and its importance? Explain the influence of cyanide and amine ligands on octahedral chromium (II) complexes and Δ_o variation.
Spectrochemical series importance with examples – 4 marks
Diagram of Δ_o variation $[\text{Cr}(\text{CN})_6]^{3-}$ and $[\text{Cr}(\text{NH}_3)_6]^{3+}$ based on weak and strong field ligands with explanation - 6 marks
(OR)
- b. i. Write short note on structural and ionization isomerism in coordination compounds. (5 Marks)
Discussion on structural & ionization isomerism – (1.5 * 2) 3 marks
Examples - 2 marks
- ii. Calculate the shielding constant and effective nuclear charge for a valence electron in fluorine. (5 Marks)
Calculation of Z^* for a valence electron in F

- F: $(1s^2)(2s^2, 2p^5)$ – 1 Mark
- Rule 2 does not apply – 1 Mark
- Shielding constant $S = (6 \times 0.35) + (2 \times 0.85) = 3.8$ (2 Marks)
- $Z^* = Z - S = 9 - 3.8 = 5.2$ (1 Mark)

- 7 a. i Calculate the wavelength of the light absorbed by $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ complex with a wave number of $25,000 \text{ cm}^{-1}$? (5 Marks)

Wavelength (\AA) = $10^8 / \text{wave number in } \text{cm}^{-1} = 10^8 / 25,000 = 4000 \text{ \AA}$ (4 marks)

Unit– 1 mark

- ii. Calculate the magnetic moment of $\text{K}_3[\text{Fe}(\text{oxalate})_3] \cdot 3\text{H}_2\text{O}$ and K_2CuCl_4 complexes. (5 Marks)

Magnetic moment of $\text{K}_3[\text{Fe}(\text{oxalate})_3] \cdot 3\text{H}_2\text{O}$; d^5 , e^- distribution – $t^3_{2g} e^2_g$, 5 unpaired e^- ; Magnetic moment: 5.91 BM (2 marks)

Magnetic moment of K_2CuCl_4 ; d^9 , e^- distribution – $e^4_g t^5_{2g}$, 1 unpaired e^- ;

Magnetic moment: 1.73 BM (2 marks)

Units: 1 Mark

(OR)

- b. i. Draw the cis and trans isomers of $[\text{Co}(\text{en})_2\text{Cl}_2]$ complexes. (4 Marks)

Diagram of $[\text{Co}(\text{en})_2\text{Cl}_2]$ complex showing cis isomerism – 2 marks

Diagram of $[\text{Co}(\text{en})_2\text{Cl}_2]$ complex showing trans isomerism – 2 marks

- ii. Explain briefly about high spin and low spin complexes with examples. (5 Marks)

Explanation based on strong field and weak field ligands influencing magnetic properties of transition metal complexes - 3 marks

Examples - 2 marks

INTERNAL ASSESSMENT – I (CLA1-T1)

Program: B.Tech
Course Code & Title: 21CYB101J & Chemistry
Year & Sem: I Year & I Sem

Date: 11/09/2023
Duration: 12.30-1.20pm
Max. Marks: 25 marks

Part – A (5 x 1 = 5 Marks)

Answer ALL The Questions

- 1 When the valence d orbitals of the central metal ion in octahedral complex are split in energy levels in CFT, which orbitals are raised to higher energy?
(d) $d_{x^2-y^2}$ and d_{z^2}
- 2 The crystal field splitting energy (Δ_o) is inversely proportional to
(b) number of d-electrons
- 3 In which of the following octahedral complexes of chromium, will the magnitude of Δ_o be the lowest?
(a) $[\text{CrCl}_6]^{3-}$
- 4 How many geometrical isomers are possible for $[\text{Co}(\text{NH}_3)_3(\text{NO}_2)_3]$ complex
a) 2
- 5 The number of unidentate ligands in the complex ion is called
b) Coordination number

Part – B (2 x 10 = 20 Marks)

6. a. i. Calculate the CFSE of d^4 and d^7 in high spin tetrahedral complexes in terms of Δ_o (6 Marks)
Energy level diagram showing electrons distribution over e_g and t_{2g} sets for d^4 and d^7 - 2 marks
CFSE calculation for d^4 ion, d e^- distribution – $e_g^2 t_{2g}^2$; CFSE – $0.18 \Delta_o$ (2 Marks)
CFSE calculation for d^7 ion, d e^- distribution – $e_g^4 t_{2g}^3$; CFSE – $0.54 \Delta_o$ (2 Marks)
- ii. Write short note on linkage and hydrate isomerism in coordination compounds. (4 Marks)
Explanation on linkage isomerism with examples - 2 marks
Explanation on hydrate isomerism with examples - 2 marks
(OR)
- b. i. Calculate the energy of the $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ complex with a wavenumber of $20,000 \text{ cm}^{-1}$? (5 Marks)

INTERNAL ASSESSMENT – I

Program: B.Tech
Course Code & Title: 21CYB101J & Chemistry
Year & Sem: I Year & I Sem

Date: 13/09/2023
Duration: 08:00 – 08:50 AM
Max. Marks: 25 marks

Part – A (5 x 1 = 5 Marks)

Answer ALL The Questions

1. Among the following complexes, the one which shows zero crystal field stabilization energy (CFSE) is
(b) $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$
2. In which of the following octahedral complexes of chromium, will the magnitude of Δ_o be the lowest?
(a) $[\text{CrCl}_6]^{3-}$
3. The Sc^{3+} complex is colourless in nature which is mainly due to
(c) Empty d-orbitals
4. The spin only magnetic moment of $\text{K}_3[\text{Mn}(\text{NO}_2)_6]$ is
(d) ~ 2.83
5. Shielding constant for a 2p electron in Nitrogen atom is _____
(a) 3.1

Part – B (2 x 10 = 20 Marks)

6. a. Based on CFT, find out the number of unpaired electrons for a Mn^{2+} complex in strong and weak octahedral field. Calculate CFSE (Δ_o) and magnetic moment for both the situation. Explain your answer with appropriate energy level diagrams. (10 Marks)
For mentioning the number of d electrons and drawing proper splitting diagram : 4 marks
Calculation of CFSE and magnetic moment for strong octahedral field : 3 marks
Calculation of CFSE and magnetic moment for weak octahedral field : 3 marks

(OR)

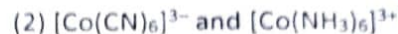
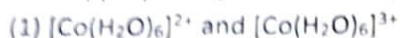
$$1 \text{ kJ/mol} = 83.6 \text{ cm}^{-1} - 1 \text{ mark}$$

$$1 \text{ cm}^{-1} = 1/83.6 \text{ kJ/mol} - 1 \text{ mark}$$

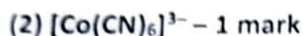
$$\text{So, } 20,000 \text{ cm}^{-1} = 20,000/83.6 \text{ kJ/mol} = 239.23 \text{ kJ/mol} - 2 \text{ marks}$$

Unit – 1 mark

- ii. Which among the following complexes have large crystal field splitting in each pair with appropriate justification? (5 Marks)



Explanation based on cation with higher oxidation state has larger value of Δ_o – 1.5 marks



Explanation based on Δ_o increasing with increase of ligand field strength – 1.5 marks

- 7 a. Give the steps for Slater's rule and using it, calculate Z_{eff} for an electron residing in 2p level for F^- ion (Z for Fluorine atom is 9).

Slater rule steps : 5 marks

Calculation of Z^* for a 2p electron in F^- ion

- **F: $(1s^2)(2s^2, 2p^6)$ – 1 Mark**
- **Rule 2 does not apply – 1 Mark**
- **Shielding constant $S = (7 \times 0.35) + (2 \times 0.85) = 4.15$ (2 Marks)**

$$Z^* = Z - S = 9 - 4.15 = 4.85 \text{ (1 Mark)}$$

(OR)

- b. i. Draw the cis and trans isomers of $[\text{Co}(\text{NH}_3)\text{Br}(\text{en})_2]^{2+}$ complexes. (5 Marks)

Diagram of $[\text{Co}(\text{NH}_3)\text{Br}(\text{en})_2]^{2+}$ complex showing cis isomerism – 2.5 marks

Diagram of $[\text{Co}(\text{NH}_3)\text{Br}(\text{en})_2]^{2+}$ complex showing trans isomerism – 2.5 marks

- ii. Calculate the magnetic moment of $(\text{Et}_4\text{N})_2[\text{FeCl}_4]^{2-}$ and $[\text{Ni}^{2+}(\text{H}_2\text{O})_6]\text{Cl}_2$ complexes. (5 Marks)

Magnetic moment of $(\text{Et}_4\text{N})_2[\text{FeCl}_4]^{2-}$; d^6 , e^- distribution – $e^3_g t^3_{2g}$, 4 unpaired e^- , Magnetic moment: 4.9 BM (2 Marks)

Magnetic moment of $[\text{Ni}^{2+}(\text{H}_2\text{O})_6]\text{Cl}_2$ – d^8 , e^- distribution – $t^6_{2g} e^2_g$, 2 unpaired e^- , Magnetic moment: 2.82 BM (2 Marks)

Units: 1 Mark

ANSWER KEY, INTERNAL ASSESSMENT – I (T-1)

Program: B.Tech
Course Code & Title: 21CYB101J & Chemistry
Year & Sem: I Year & I Sem

Date: 13/09/2023
Duration: 08.00 – 08.50 AM
Max. Marks: 25 marks

Part – A (5 x 1 = 5 Marks)

Answer ALL The Questions

1. In CFT, the strong field ligand such as CO usually produces:
(c) low spin complexes and high crystal field splitting
2. CFSE for $e^p t_2^q$ configuration of tetrahedral complex is
(b) $[-0.27p + 0.18q] \Delta_o$
3. How many unpaired electrons are present in a strong field Mn(II) octahedral complex?
(b) 1
4. The effective nuclear charge realized by a 1s electron of Helium atom is
(d) 1.7
5. The spin only magnetic moment of $K_3[Fe(C_2O_4)_3]$ is
(b) ~ 5.9

Part – B (2 x 10 = 20 Marks)

6. a. i Write a short note on spectrochemical series? Explain with a suitable example, the influence of ligands in the formation of high and low spin complexes. (6 Marks)

Definition and series of ligands – 2 Marks

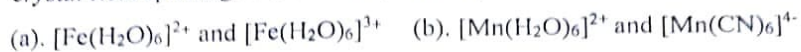
Splitting diagram of HS and LS complex with explanation of an example – 4 Marks

- ii. $[Ti(H_2O)_6]^{3+}$ is coloured, while $[Sc(H_2O)_6]^{3+}$ is colourless – Explain. (4 marks)

Ti^{3+} - $3d^1$ configuration; d – d transition is possible. So, coloured complex.
– 2 Marks

Sc^{3+} - $3d^0$ configuration; d – d transition is not possible. So, colourless complex. –2 Marks

- b. i. Elucidate which of the following complexes in each pair given below will have large crystal field splitting of d-orbitals (4 Marks)



Correct answer: 2marks

Explanation: 2 marks

- ii. Discuss in detail any two factors that influence the magnitude of crystal field splitting, Δ_o . (6 Marks)

Any two factors with example: 2 x 3 Marks (each) = 6 Marks

- 7 a. i. Predict the possible type of isomerism that can exist for the octahedral complex having the formula $\text{CoBrSO}_4 \cdot 5\text{NH}_3$. Write down the isomers and elucidate how the isomers can be differentiated? (6 Marks)

Definition of ionisation isomerism: 1 mark

Writing the two isomers: 2 marks

Explaining any one test to differentiate the isomers: 3 marks

- ii. Calculate Z^* for a 4s electron in Iron (Z of Iron is 26) (4 Marks)

Correct answer : Z_{eff} for a 4s electron is 3.75 (4 marks)

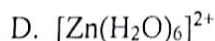
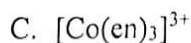
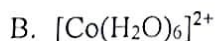
(OR)

- b. i. Draw the crystal field splitting diagrams for an octahedral crystal field and a tetrahedral crystal field of Cu^{2+} coordination complex. Label the d-orbitals and comment on the magnetic behaviour. (6 Marks)

Crystal field splitting diagrams: 3 marks

Magnetic behaviour with justification: 3 marks

- ii. Which of the following complexes will exhibit maximum attraction to an applied magnetic field? Rationalise your answer. (4 Marks)



Correct answer: Based on the number of unpaired electrons, the complex with the maximum attraction to an applied magnetic field is $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ (Option B), as it has 3 unpaired electrons. 4 marks

Part – A (5 x 1 = 5 Marks)

Answer ALL The Questions

- CFSE for $t_{2g}^p e_g^q$ configuration of octahedral complex is
 (a) $[-0.4p + 0.6q] \Delta_o$
- Among the following, which is the π donor ligand?
 (d) Cl^-
- In which of the following octahedral complexes of chromium, will the magnitude of Δ_o be the lowest?
 (a) $[CrCl_6]^{3-}$
- The effective nuclear charge realised by 1s electron of helium atom is ____
 (b) 0.30
- Which of the following metal ions form sulphides?
 (b) Ag^+ and Hg^{2+}

Part – B (2 x 10 = 20 Marks)

6. a. The energy gap between t_{2g} and e_g of an octahedral complex is 239.23 kJ/mol ($1 \text{ kJ/mol} = 83.6 \text{ cm}^{-1}$). Find the wavelength absorbed by the complex for d-d transition and predict colour of the sample based on complementary colour. (10 Marks)

$1 \text{ kJ/mol} = 83.6 \text{ cm}^{-1}$ So, $239.23 \text{ kJ/mol} = 20000 \text{ cm}^{-1}$ – 2 marks

Wavelength (\AA) = $10^8 / \text{wave number in cm}^{-1} = 10^8 / 20000 \text{ cm}^{-1} = 5000 \text{ \AA} = 500 \text{ nm}$
 – 5 marks

Colour absorbed – Green / Colour of the sample based on complementary colour
 – Violet/Purple – 3 Marks

(OR)

- b. i. Write down the salient features of Crystal Field Theory. (4 Marks)

Salient features – 4 Marks

- ii. Determine CFSE and magnetic moment of a d^6 octahedral complex having $\Delta_o = 25000 \text{ cm}^{-1}$ and $P = 15000 \text{ cm}^{-1}$. (6 Marks)

Mentioning that the complex is low spin due to high Δ_o as comparing to P value and drawing the energy diagram and mentioning the number of electrons in t_{2g} and e_g – 2 Marks

$\Delta_o > P$
 $\Delta_o < P$

(OR)

- b. i. Give proper justification for the statement "Only high spin tetrahedral complexes are known". (6 Marks)

Splitting pattern – 3 marks; Explanation: In case of tetrahedral complex, since $\Delta_t < P$, the electrons tend to remain unpaired and hence only high spin tetrahedral complexes are known – 3 marks

- ii. A tetrahedral complex absorbs at 545 nm. What is the respective octahedral crystal field splitting (Δ_o)? (4 Marks)

Calculation of Δ_t : 3.65×10^{-19} J, However, the tetrahedral splitting (Δ_t) is $\sim 4/9$ that of the octahedral splitting (Δ_o) : 2 Marks

$\Delta_o = \Delta_t/0.44$ and hence answer is 8.3×10^{-18} J: 2 Marks

- 7 a. i Predict the possible type of isomerism that can exist for the octahedral complex $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$. Write down the isomers and elucidate how the isomers can be differentiated? (6 Marks)

Definition of hydrate isomerism: 1 mark

Writing the three isomers: 3 marks

Explaining any one test to differentiate the isomers: 2 marks

- ii. Calculate Z^* for a 4s electron in Zinc (Z of Zinc is 30) (4 Marks)

(OR)

- $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$
- $(1s^2)(2s^2, 2p^6)(3s^2, 3p^6)(3d^{10})(4s^2)$
- $(0.35 \times 1) + (0.85 \times 18) + (10 \times 1.00) = 25.65$

$Z^* = 30 - 25.65 = 4.35$ for a valence electron (4 marks)

- b. i. $[\text{Co}(\text{NH}_3)_6]^{3+}$ is diamagnetic and orange yellow. $[\text{CoF}_6]^{3-}$ on the other hand is paramagnetic and blue. Justify. (5 Marks)

Electron configuration and splitting pattern: 2.5 marks

Justification based on above: 2.5 marks

- ii. Explain the salient features and the limitations of CFT. (5 Marks)

Salient features: 2.5 Marks

Limitations: 2.5 Marks

INTERNAL ASSESSMENT – I

Program: B.Tech
 Course Code & Title: 21CYB101J & Chemistry
 Year & Sem: 1 Year & I Sem

Date: 11/10/2022
 Duration: 08:00 – 08:50 AM
 Max. Marks: 25 marks

Part – A (5 x 1 = 5 Marks)

Answer ALL The Questions

1. The crystal field splitting energy (Δ_o) is directly proportional to
(d) oxidation state
2. In spectrochemical series, the order of ligands is
(c) π donor < σ donor < π acceptor
3. The Sc^{3+} complex is colourless in nature which is mainly due to
(c) Empty d-orbitals
4. The second ionisation energy is always higher than the first ionization energy because the
(b) electron is more tightly bound to the nucleus in an ion
5. All cations and molecules that are short of an electron pair act as _____
(a) Lewis acids

Part – B (2 x 10 = 20 Marks)

6. a. Find out the number of unpaired electrons in strong and weak octahedral field for Mn^{2+} complex based on CFT. Calculate CFSE and magnetic moment for both the situation with energy level diagrams. (10 Marks)
For mentioning number of d electrons ($\text{Mn}^{2+} - d^5$) and d-orbital splitting diagram with electron filling for strong and weak octahedral field – 2 Marks
CFSE and Magnetic moment calculation and answer for strong octahedral field – 4 marks
CFSE and Magnetic moment calculation and answer for weak octahedral field – 4 marks

(OR)

- b. i. Which of the following complexes have large crystal field splitting of d-orbitals in each pair and why? (5 Marks)
(a). $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ - 2.5 marks
Explanation on the influence of oxidation number on the crystal field splitting and $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ have large crystal field splitting
(b). $[\text{Fe}(\text{CN})_6]^{3-}$ and $[\text{Fe}(\text{NH}_3)_6]^{3+}$ - 2.5 marks

CFSE and Magnetic moment calculation and answer – 4 Marks

- 7 a. i Calculate the magnetic moment of $[\text{Co}(\text{NH}_3)_6]^{3+}$ and $[\text{CoF}_6]^{3-}$ complexes. (4 Marks)
Magnetic moment of $[\text{Co}(\text{NH}_3)_6]^{3+}$ - d⁶ low spin– 0 BM - 2 Marks
Magnetic moment of $[\text{CoF}_6]^{3-}$ - d⁶ high spin– 4.9 BM - 2 Marks
- ii. What is the shielding constant experienced by a 3d electron in the bromine atom (Number of Protons = 35)? Calculate the effective nuclear charge for the same. (6 Marks)

- Br: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$ – 1 Mark
- Br: $(1s^2)(2s^2, 2p^6)(3s^2, 3p^6)(3d^{10})(4s^2, 4p^5)$ – 1 Mark
- Ignore the group to the right of the 3d electrons. These do not contribute to the shielding constant – 1 Mark
- $S = 1.00(18) + 0.35(9) = 21.15$ – 2 Mark
- $Z^* = Z - S = 35 - 21.15 = 14.85$ for a valence electron – 1 Mark

(OR)

- b. i. Define atomic radii? Give its variation along the period and down the group taking examples. Arrange the following in the increasing order of atomic radii and give reasons: N, S, P and O. (5 Marks)

Definition of Atomic radii – 3 Marks

Atomic radii: $O < N < S < P$ – explanation with effective nuclear charge – 3 Marks

- ii. Explain complex formation of thiocyanate ligand with Fe^{3+} and Au^+ ions using HSAB concept. (5 Marks)

SCN- vs. NCS- Thiocyanate (SCN-) is an ambidentate ligand. It can bind to metal ions either through the S or the N. It prefers to bind to soft metal ions through the S, and to hard metal ions through the N.

- N-bonding in the $[\text{Fe}(\text{NCS})_6]^{3-}$ complex with the hard $\text{Fe}(\text{III})$ ion
- S-bonding in the $[\text{Au}(\text{SCN})_2]^+$ complex with the soft $\text{Au}(\text{I})$ ion

ANSWER-KEY
INTERNAL ASSESSMENT - I

Program: B.Tech
Course Code & Title: 21CYB101J & Chemistry
Year & Sem: I Year & II Sem

Date: 13/02/2023
Duration: 8.00 – 8.50 AM
Max. Marks: 25 marks

Part – A (5 x 1 = 5 Marks)

Answer ALL The Questions

1. Which of the following complex is paramagnetic? (Z of Cu = 29, Fe = 26, Co = 27)
(c) $[\text{CoBr}]_4^{2+}$
2. The correct increasing order of splitting power of ligands according to spectrochemical series is
(a) $\text{Cl}^- < \text{OH}^- < \text{CN}^-$
3. Which one of the following ions exhibits colour in aqueous solution?
(b) Ni^{2+}
4. Which of the following order is correct for the first ionization energies of following elements?
(c) $\text{B} < \text{Be} < \text{O} < \text{N}$
5. According to HSAB theory, which option shows negative correlation with hardness?
(b) Polarizability

Part – B (2 x 10 = 20 Marks)

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

Crystal Field Splitting Diagram- 3 Marks,

Explanation – 3 Marks,

CFSE formula – 2 marks

Magnetic moment – 2 marks

(OR)

- b. i. For Mn^{2+} ion, $P = 28,000 \text{ cm}^{-1}$ and Δ_o value for $[\text{Mn}(\text{CN})_6]^{3-}$ ion is $38,500 \text{ cm}^{-1}$. Predict whether the complex is high spin or low spin. Write the configuration and calculate CFSE in cm^{-1} .

Ans: Low spin, $\text{CFSE} = -33600 \text{ cm}^{-1}$

$[\text{Mn}(\text{CN})_6]^{3-}$ has $t_{2g}^4 e_g^0$ (6 Marks)

$$\text{CFSE} = -\frac{2}{5} \times 4 \times 38500 + 28000 \times 1 = -33,600 \text{ cm}^{-1}$$

(P)

Explanation on the influence of ligands (spectrochemical series) on the crystal field splitting and $[\text{Fe}(\text{CN})_6]^{3-}$ have large crystal field splitting

- ii. Calculate the wavelength of the light absorbed by octahedral complex with a frequency of $24,000 \text{ cm}^{-1}$? (5 Marks)

$$\text{Wavelength } (\text{\AA}) = 10^8 / \text{wave number in cm}^{-1} = 10^8 / 17,830 = 5609 \text{ \AA} = 560.9 \text{ nm}$$

- 7 a. i. Predict the possible type of isomerism can exist for the octahedral complex when the central metal ion is Co^{2+} surrounded by 5 NH_3 molecule, 1 Br^- and 1 SO_4^{2-} ions. Write down the isomers and how to test the difference among the isomers? (6 Marks)

Ionization Isomerism – 1 Mark

$[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ & $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$ Isomers – 3 Marks

Mentioning the test to differentiate - 2 Mark

- $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ gives white ppt. of BaSO_4 with aq. BaCl_2 while $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$ does not.
- Similarly $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$ gives yellow ppt. of AgBr with aq. silver nitrate, while $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ does not.

- ii. Explain why electron affinity of chlorine is more than that of fluorine. (4 Marks)

Due to smaller size of F and electron - electron repulsion – 4 Marks

(OR)

- b. i. Why Cl^- ion will be bigger than Cl (Atomic Number = 17)? Justify using Slater's Rule. (6 Marks)

Slater's rule step by step approach – 1 Mark

Calculate effective nuclear charge for Cl – 2 Marks

Calculate effective nuclear Charge for Cl^- - 2 Marks

Discussion about size difference by comparing effective nuclear charge of Cl and Cl^- - 1 Mark

- ii. Give the differences between hard and soft acids. (4 Marks)

Any four differences - 4 Marks

- b. i. Calculate CFSE values in terms of Δ_o and P for high and low spin octahedral complexes of Fe (II). Predict whether the complexes are paramagnetic or diamagnetic? (4 Marks)

Ans: High spin: $-0.4 \Delta_o + P$, paramagnetic – 2 marks
Low spin: $-2.4 \Delta_o + 3P$, diamagnetic – 2 marks

- ii. Which of the following complexes have large crystal field splitting of d-orbitals in each pair and why?

(a) $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ (b) $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$
(c) $[\text{Co}(\text{NH}_3)_6]^{3+}$ and $[\text{Rh}(\text{NH}_3)_6]^{3+}$ (6 Marks)

Ans: (a) $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ - Higher oxidation state – 2 marks

(b) $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ - lower number of d electrons – 2 marks

(c) $[\text{Rh}(\text{NH}_3)_6]^{3+}$ - higher quantum number of d orbital of metal centre – 2 marks

- 7 a. i Define 'Ionization Energy', discuss factors affecting it and its variation across the period & down the group in a periodic table. (10 Marks)

Ans: Definition – 2 marks, any four factors – 4 marks, variation across period – 2 marks, variation down the group – 2 marks

(OR)

- b. i. Calculate Effective Nuclear Charge (Z_{eff}) for 3d electron of V ($Z = 23$) (6 Marks)

Ans: 4.30

Electronic configuration – 1 marks, Formula for Z_{eff} – 1 mark, calculation of screening constant – 3 marks, calculation of Z_{eff} – 2 marks.

- ii. Explain complex formation of SCN^- with Pt^{2+} and Cr^{3+} . (4 Marks)

Ans: Explanation based on HSAB principle – 4 marks

Kattankulathur – 603203
ANSWER-KEY
INTERNAL ASSESSMENT – I

Program: B.Tech
Course Code & Title: 21CYB101J & Chemistry
Year & Sem: I Year & II Sem

Date: 13/02/2023
Duration: 8.00 – 8.50 AM
Max. Marks: 25 marks

Part – A (5 x 1 = 5 Marks)

Answer ALL The Questions

- Which of the following complexes has a magnetic moment of 1.73 BM?
(Z of Ni = 28, Ti = 22, Cu = 29, Co = 27)
(c) $[\text{Cu}(\text{NH}_3)_4]^{2+}$
- The correct electronic configuration of the central atom in $\text{K}_4[\text{Fe}(\text{CN})_6]$ based on crystal field theory is
(c) $t_{2g}^6 e_g^0$
- Out of TiF_6^{2-} , CoF_6^{3-} , $\text{Fe}(\text{CN})_6^{4-}$ and NiCl_4^{2-} (Z of Ti = 22, Co = 27, Fe = 26, Ni = 28), the colourless species is :
(a) TiF_6^{2-}
- The electron affinity for the inert gases is
(a) 0
- According to hard and soft acid base principle, hard acid
(a) is not polarizable

Part – B (2 x 10 = 20 Marks)

6. a. Describe structural isomerism in co-ordination compounds with suitable examples.
(10 Marks)

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

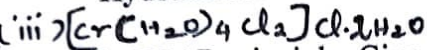
(OR)

- ii. Write the formula for ionization isomer of $[\text{Co(en)}_2\text{Cl.SCN}]\text{NO}_2$ and hydration isomer of $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$ (4 Marks)

Ans: Ionization isomers – 2 marks

Hydration isomers – 2 marks

dark green
color
7 a.



Explain HSAB principle. Give its applications and limitations.

(10 Marks)

Ans: Features of HA, SA, HB, SB, HSAB principle with explanation – 6 marks

Two applications – 2 marks

Two limitations – 2 marks

(OR)

- b. i. Calculate the octahedral crystal field splitting energy in kJ for $[\text{Fe}(\text{CN})_6]^{4-}$, if the wavelength of the most intensely absorbed light is 305 nm.

($h = 6.626 \times 10^{-34} \text{ Js}$, $c = 2.99 \times 10^8 \text{ m/s}$)

(6 Marks)

Ans: $6.513 \times 10^{-22} \text{ kJ}$ or 392 kJ/mol

- ii. Atomic size decreases from Li to F in a second period, however from F to Ne it increases, explain.

(4 Marks)

Ans: Explanation for decrease in size from Li to F – 2 marks

Explanation for increase from F to Ne (mention of atomic and Van der Waals radius) – 2 marks