



## CT-1Q - Ct's for practise

Chemistry (SRM Institute of Science and Technology)



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DEPARTMENT OF CHEMISTRY  
College of Engineering and Technology  
SRM Institute of Science and Technology  
Kattankulathur – 603 203

SET – 1

INTERNAL ASSESSMENT – I (CLA1-T1)

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

Date: 11-09-2023  
Time: 8.00-8.50am  
Max. Marks: 25 marks

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

- The crystal field splitting energy of an octahedral complex is  $18,000\text{ cm}^{-1}$ . What will be the energy in terms of  $\Delta_0$  ?  
a)  $40,500\text{ cm}^{-1}$       b)  $8100\text{ cm}^{-1}$       c)  $36,000\text{ cm}^{-1}$       d)  $9000\text{ cm}^{-1}$
- The number of unpaired electrons present in  $[\text{Fe}(\text{CN})_6]^{4-}$  is  
a) 0      b) 1      c) 2      d) 3
- Arrange the following ligands, en,  $\text{NH}_3$ ,  $\text{H}_2\text{O}$  and  $\text{CN}^-$  in their decreasing order of field strength  
a)  $\text{NH}_3 > \text{CN}^- > \text{H}_2\text{O} > \text{en}$   
b)  $\text{en} > \text{CN}^- > \text{H}_2\text{O} > \text{NH}_3$   
c)  $\text{CN}^- > \text{en} > \text{NH}_3 > \text{H}_2\text{O}$   
d)  $\text{CN}^- > \text{en} > \text{H}_2\text{O} > \text{NH}_3$
- The complexes  $[\text{Co}(\text{NH}_3)_6][\text{Cr}(\text{C}_2\text{O}_4)_3]$  and  $[\text{Cr}(\text{NH}_3)_6][\text{Co}(\text{C}_2\text{O}_4)_3]$   
(a) Linkage isomerism  
(b) Geometrical isomerism  
(c) Coordination isomerism  
(d) Ionisation isomerism
- The shielding constant of 1s electron in helium atom is \_\_\_\_\_  
a) 1.70      b) 0.35      c) 1.65      d) 0.30

**Part – B (2 x 10 = 20 Marks)**

6. a. (i) Discuss the salient features of crystal field theory. (4 Marks)  
 (ii) Identify the complex possessing the larger value of  $\Delta_o$  in the following pairs and give reason. (6 Marks)  
 (A)  $[\text{Ni}(\text{CN})_6]^{4-}$  and  $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$   
 (B)  $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$  and  $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$   
 (C)  $[\text{Rh}(\text{NH}_3)_6]^{3+}$  and  $[\text{Ir}(\text{NH}_3)_6]^{3+}$

(OR)

- b. Discuss the crystal field splitting of a tetrahedral complex. Calculate the CFSE and magnetic moment of  $[\text{NiCl}_4]^{2-}$  (Atomic number of Ni is 28). (10 Marks)
7. a. Brief about the following isomerism exhibited by the coordination compounds with a suitable example for each. (3+3+4 Marks)  
 (i) Ionization  
 (ii) Hydrate  
 (iii) Geometrical

(OR)

- b. (i) The UV-Visible spectrum of an octahedral complex showed  $\lambda_{\text{max}}$  at 600 nm. Calculate the crystal field splitting energy,  $\Delta_o$  and complementary colour of the complex? (6 Marks)  
 (ii) Determine the effective nuclear charge experienced by the 4p electron of Bromine. [Atomic number of Br = 35]. (4 Marks)

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**ANSWER KEY**

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

- The crystal field splitting energy of an octahedral complex is  $18,000 \text{ cm}^{-1}$ . What will be the energy in terms of  $\Delta_o$ ?  
b)  $8100 \text{ cm}^{-1}$
- The number of unpaired electrons present in  $[\text{Fe}(\text{CN})_6]^{4-}$  is  
a) 0
- Arrange the following ligands, en,  $\text{NH}_3$ ,  $\text{H}_2\text{O}$  and  $\text{CN}^-$  in their decreasing order of field strength  
c)  $\text{CN}^- > \text{en} > \text{NH}_3 > \text{H}_2\text{O}$
- The complexes  $[\text{Co}(\text{NH}_3)_6][\text{Cr}(\text{C}_2\text{O}_4)_3]$  and  $[\text{Cr}(\text{NH}_3)_6][\text{Co}(\text{C}_2\text{O}_4)_3]$   
c) Coordination isomerism
- The shielding constant of 1s electron in helium atom is \_\_\_\_\_  
d) 0.30

**Part – B (2 x 10 = 20 Marks)**

- Discuss the salient features of crystal field theory. (4 Marks)  
**Important features of CFT – 4 Points – 4 Marks**
    - Identify the complex possessing the larger value of  $\Delta_o$  in the following pairs and give reason. (6 Marks)  
**Explanation for the high value of  $\Delta_o$  in each pair– 2 Marks – (3x2 = 6 Marks)**  
(OR)
  - Discuss the crystal field splitting of a tetrahedral complex. Calculate the CFSE and magnetic moment of  $[\text{NiCl}_4]^{2-}$  (Atomic number of Ni is 28). (10 Marks)

Crystal Field Splitting Diagram- 2 Marks,  
 Explanation on d – orbitals splitting – 4 Marks,  
 CFSE calculation – 2 Marks  
 Magnetic moment calculation – 2 Marks

7. a. Brief about the following isomerism exhibited by the coordination compounds with a suitable example for each. (3+3+4 Marks)
- (i) Ionization isomerism - definition with an example – 3 Marks
  - (ii) Hydrate isomerism - definition with an example – 3 Marks
  - (iii) Geometrical isomerism - definition with an example – 4 Marks

(OR)

- b. (i) The UV-Visible spectrum of an octahedral complex showed  $\lambda_{\text{max}}$  at 600 nm.

Calculate the crystal field splitting energy,  $\Delta_o$  and complementary colour of the complex? (6 Marks)

$$\Delta_o = hc/\lambda = (6.626 \times 10^{-34} \text{ J.s})(3 \times 10^8 \text{ cm/s}) / (600 \times 10^{-9} \text{ m}) = 3.313 \times 10^{-19} \text{ J} \quad - 4 \text{ Marks}$$

Wavelength of light absorbed is 600 nm (i.e. orange light) and hence the complementary colour of the complex is blue – 2 Marks

- (ii) Determine the effective nuclear charge experienced by the 4p electron of Bromine. [Atomic number of Br = 35]. (4 Marks)

Slater configuration of Br:  $(1s^2) (2s^2 2p^6) (3s^2 3p^6) (3d^{10}) (4s^2 4p^5)$  - 1 Mark

Shielding Constant of 4p =  $[(10 \times 1) + (18 \times 0.85) + (6 \times 0.35)] = 27.4$  – 2 Marks

Effective nuclear charge =  $35 - 27.4 = 7.60$  – 1 Mark

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Part – A (5 x 1 = 5 Marks)

Answer ALL the Questions

- Among the following complexes, the one which shows zero crystal field stabilization energy (CFSE) is  
a)  $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$       b)  $[\text{Mn}(\text{H}_2\text{O})_6]^{3+}$       c)  $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$       d)  $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$
- The complex possessing high magnetic moment value is \_\_\_\_\_  
(a)  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$       (b)  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$   
(c)  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$       (d)  $[\text{Zn}(\text{H}_2\text{O})_6]^{2+}$
- Which one of the following complexes is not coloured?  
a)  $[\text{Cu}(\text{Cl}_4)]^{2-}$       b)  $[\text{Cd}(\text{Cl}_4)]^{2-}$       c)  $[\text{Fe}(\text{Cl}_6)]^{4-}$       d)  $[\text{Fe}(\text{CN})_6]^{4-}$
- The type of isomerism shown by  $[\text{CoCl}_2(\text{en})_2]$  is  
a) Ionization      b) Geometrical      c) Linkage      d) Coordination
- The effective nuclear charge of 2s electron in Beryllium atom is \_\_\_\_\_  
a) 2.05      b) 1.95      c) 0.70      d) 3.30



**Part – B (2 x 10 = 20 Marks)**

6. a. Describe the crystal field splitting of an octahedral complex with neat diagram. Show the CFSE and magnetic moment calculations of both low spin and high spin complexes for the metal ion with  $d^7$  electron configuration. (10 Marks)

(OR)

- b. (i) Write a short note on Spectrochemical series. (4 Marks)  
(ii) Compare the CFSE and magnetic moment values of  $[\text{MnCl}_4]^{2-}$  and  $[\text{CoCl}_4]^{2-}$  and  $[\text{CuCl}_4]^{2-}$  complexes. [Atomic numbers of Mn, Co and Cu are 25, 27 and 29 respectively]. (6 Marks)

7. a. Discuss the following isomerism shown by the coordination compounds with a suitable example for each. (3+3+4 Marks)

- (i) Linkage
- (ii) Coordination
- (iii) Optical

(OR)

- b. (i) Arrange the following complexes in their increasing order of wavelength of light absorbed and explain. (6 Marks)  
 $[\text{CrF}_6]^{3-}$ ,  $[\text{Cr}(\text{CN})_6]^{3-}$  and  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$
- (ii) Calculate the effective nuclear charge experienced by the 3d electron of Zn [Z=30]. (4 Marks)

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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  
a)  $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$
- 2 The complex possessing high magnetic moment value is \_\_\_\_\_  
b)  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$
- 3 Which one of the following complexes is not coloured?  
b)  $[\text{Cd}(\text{Cl}_4)]^{2-}$
- 4 The type of isomerism shown by  $[\text{CoCl}_2(\text{en})_2]$  is  
b) Geometrical
- 5 The effective nuclear charge of 2s electron in Beryllium atom is \_\_\_\_\_  
b) 1.95

Part – B (2 x 10 = 20 Marks)

6. a. Describe the crystal field splitting of an octahedral complex with neat diagram. Show the CFSE and magnetic moment calculations of both low spin and high spin complexes for the metal ion with  $d^7$  electron configuration. (10 Marks)  
 Crystal Field Splitting Diagram- 2 Marks,  
 Explanation on d – orbitals splitting – 4 Marks,  
 CFSE calculations (both high & low spin) – 2 Marks  
 Magnetic moment calculations (both high & low spin) – 2 Marks

(OR)

- b. (i) Write a short note on Spectrochemical series. (4 Marks)  
 Definition – 2 Marks  
 Arrangement of ligands in series – 2 Marks



- (ii) Compare the CFSE and magnetic moment values of  $[\text{MnCl}_4]^{2-}$  and  $[\text{CoCl}_4]^{2-}$  and  $[\text{CuCl}_4]^{2-}$  complexes. [Atomic numbers of Mn, Co and Cu are 25, 27 and 29 respectively]. (6 Marks)

For each complex,

CFSE calculation – 1 Mark; Magnetic moment calculation – 1 Mark.

7. a. Discuss the following isomerism shown by the coordination compounds with a suitable example for each. (3+3+4 Marks)

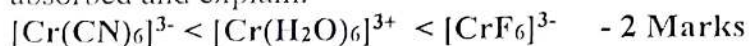
(i) Linkage – definition with an example – 3 Marks

(ii) Coordination – definition with an example – 3 Marks

(iii) Optical – definition with an example – 4 Marks

(OR)

- b. (i) Arrange the following complexes in their increasing order of wavelength of light absorbed and explain. (6 Marks)



Explanation – 4 Marks

- (ii) Calculate the effective nuclear charge experienced by the 3d electron of Zn [Z=30]. (4 Marks)

Slater configuration of Zn:  $(1s^2) (2s^2 2p^6) (3s^2 3p^6) (3d^{10}) (4s^2)$  - 1 Mark

$$\text{Screening constant} = [(18 \times 1) + (9 \times 0.35)] = 21.15 \quad - 2 \text{ Marks}$$

$$\text{Effective nuclear charge} = 30 - 21.15 = 8.85 \quad - 1 \text{ Mark}$$