Unique Paper Code	:	**42177925**
Name of the Paper	:	**DSE: Chemistry of d-block Elements, Quantum Chemistry and spectroscopy**
Name of the Course	:	**B.Sc. Prog. Life Science**
Semester	:	**V**
Duration	:	**3 hours**
Maximum Marks	:	**75**

Instruction for Candidates

1. Following details to be written on first page:
   University. Roll. No.
   Name:
   Class:
   Course:
   Semester:
   Paper Name:
   Unique paper code:
2. Put page numbers on every page of the answer script
3. Attempt **any two** questions from **each section** (Total four questions)
4. Attempt all parts of a question together.

SECTION A

Q.1.

a) Write down the IUPAC names of the following coordination compounds:

i. $K_3[Fe(CN)_5NO]$

ii. $[(en)_2Co(NH_2)(OH)Co(en)_2](SO_4)_2$

iii. $[Pt(NH_3)_4Cl_2][PtCl_4]$

iv. $[Ni(NH_3)_2(py)(Cl)]$

(2 x 4 = 8)

b) Write down the formula for the following coordination compounds

i) Ammonium tetrachloridoplatinate(II

ii) Potassium carbonyltetracyanido-C-iodidoferrate(III)

iii) Potassium trioxalatoferrate(III) trihydrate

(2 x 3 = 6)

c) Explain *Linkage isomerism* and *coordination isomerism* with the help of examples for each

4¾

Q.2.

a) VBT fails in predicting the relative stabilities of the complexes $[Co(CN)_6]^{3-}$ and $[Co(NO_2)_6]^{3-}$ while CFT can. Justify.

3

b) Define Jahn Teller distortion. Giving justification, explain which of these configurations d^3, d^4, and d^9 will undergo tetragonal distortion in octahedral ligand field?

6.5

Tetrahedral ligand field splitting is considerably lower than octahedral crystal field splitting. Explain **4**

c) Define inner orbital and Outer orbital complexes giving suitable examples in each case.

5¼

Q.3.

a) Provide a suitable explanation for the following statements:

(i) Transition elements have high enthalpies of atomisation

(ii) Zn^{2+} compounds are white while Cu^{2+} are blue in colour.

4

b) Write short notes on any two of the following:

(i) Catalytic properties of transition metals and their complexes

(ii) Advantages of CFT over VBT in coordination compounds.

(iii) Colour and magnetic properties of lanthanides

8

c) The Latimer diagram of Mn in acidic solution is given below:

$$MnO_4^- \xrightarrow{+0.90\ V} HMnO_4^- \xrightarrow{+1.28\ V} H_3MnO_4 \xrightarrow{+2.9\ V} MnO_2 \xrightarrow{+0.95\ V} Mn^{3+} \xrightarrow{+1.5\ V} Mn^{2+} \xrightarrow{-1.18V} Mn$$

(i) Which oxidation states of Mn are unstable w.r.t disproportionation in aqueous medium and why?

(ii) Can Mn(s) be a reducing agent?

(iii) Which of the above species can reduce water to H_2 in acidic medium?

(iv) What is the oxidation state of Mn in $HMnO_4^-$?

6¾

Q.4.

a) What are the photoelectric cell?

2¾

b) What are the auxochrome and chromophore? Explain with examples.

4

c) Find out that function $\phi(x)$ is an eigen function of the given operator $(\hat{A})$ or not. In case of eigen function, give its eigenvalue?

(i) $(\hat{A}) = \frac{d}{dx^2}^2$; $\phi(x) = Cos\ \omega x$

(ii) $(\hat{A}) = \frac{d}{dt}$; $\phi(x) = e^{-i\omega t}$

4

d) The spacing of lines in the microwave spectrum of $^{35}Cl^{19}F$ is 1.033 cm^{-1}; calculate moment of inertia and bond length of the molecule.

4

e) Which of the following molecules may show rotational and vibrational spectra and why?
(i) CH_3CH_3 (ii) CH_4 (iii) CH_3Cl (iv) N_2

4

Q.5.

a) What are the primary and secondary photochemical processes?

2¾

b) What are physical significance of $\psi\ and\ \psi^2$ for a particle in one dimensional box. Sketch the plot of $\psi\ and\ \psi^2$ of "a particle in one dimensional box" for n = 1 to n =5.

4

c) Explain symmetric and asymmetric stretching, and bending modes of molecules with example?

4

d) Derive the expression for the average energy ($\langle E \rangle$) for the particle in one-dimensional box of length *l* using following Wavefunction:

$$\psi_n = \sqrt{\frac{2}{l}} Sin\ \frac{n\pi x}{l} \qquad 0 \le x \le l$$

where n (principal quantum number) = 1, 2…so on

4

e) A solution of an unknown component of a biological sample when placed in an absorption cell of path length 1.00 cm transmits 18.1 percent of light of 320 nm incident upon it. What is the molar absorption coefficient, If the concentration of the component is 0.139 mmol dm^{-3}?

4

Q.6.

a) Define zero-point energy? Why is it not zero in vibrational spectra?

2¾

b) Describe absorption, fluorescence and phosphorescence. Write the increasing trend in the life time of the absorption, fluorescence and phosphorescence and also give its reason.

4

c) How many normal modes of vibration are possible for the following molecules:

(i) C_6H_6 (ii) NO_2 (iii) HC≡C-C≡C-H

4

d) What is the selection rule for the vibrational quantum number? The vibration frequency of $^1H^{35}Cl$ is 2990.6 cm^{-1} . Calculate the bond force constant.

4

e) Find out the value of the following commutators:

(i) $\left[x, \frac{d}{dx}\right]$
(ii) $[x^n, p_x]$

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