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) $[Co(NH_3)_5Cl][Zn(OH)_4]$
ii) $Na_2[Pt(NH_3)(H_2O)Cl_2]$
iii) $[(NH_3)_4Cr(OH)_2Cr(NH_3)_4]Cl_4$
iv) $[Co(en)_2ClBr]NO_3$

(2 x 4 = 8)

b) Write down the formula for the following coordination compounds

(i) Potassium dicyanido-N-dioxalatonickelate(II)
(ii) Hexaamminecobalt(III) hexachloridochromate(III)
(iii) Dichlorido*bis*(methylamine)copper(II)

(2 x 3 = 6)

c) (i) Write down the isomers of $[Cr(H_2O)_6]Cl_3$. What are these isomers called?

3

(ii) Give one method to distinguish between cis and trans isomers.

1¾

Q.2. a) Discuss drawbacks of Valence Bond Theory in reference to coordination compounds.

6

b) Based on VBT, deduce the structures of $[Fe(CN)_6]^{4-}$ (diamagnetic) and $[Cr(NC)_6]^{3-}$ (paramagnetic) complex.

5

c) Draw a neatly labelled orbital splitting diagram for a transition metal ion in octahedral and tetrahedral ligand fields. Explain why the two diagrams are different?

6

d) How does CFT helps in explaining the colours of transition metal complexes?

1¾

Q.3. a) Provide suitable explanations for the following statements:

(i) The ionic radii of transition metal ions vary irregularly down the group.

(ii) The paramagnetic susceptibility of transition metals of 3d series increases upto Mn and then decreases.

4

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

(i) Separation of Lanthanides

(ii) Origin of colour in Transition metal salts and complexes

(iii) Factors affecting the magnitude of Crystal field stabilisation energy

8

c) Consider the Latimer diagram for iron in acidic and alkaline mediums to answer the following statements:

Acidic: FeO_4^{2-} $\xrightarrow{>1.9\ V}$ Fe^{3+} $\xrightarrow{+0.77V}$ Fe^{2+} $\xrightarrow{-0.44\ V}$ Fe

Basic: FeO_4^{2-} $\xrightarrow{+0.81V}$ Fe^{3+} $\xrightarrow{-0.86V}$ Fe^{2+} $\xrightarrow{-0.89V}$ Fe

(i) In which medium, acidic or alkaline, Fe (VI) and Fe (II) are more stable?

(ii) Is there any species likely to undergo disproportionation?

(iii) Will atmospheric oxygen oxidise acidic solution of green Fe^{2+} to yellow brown Fe^{3+} ?

(iv) Which species has the highest oxidation state of Fe?

6¾

SECTION B

Q.4.

a) What are the "Laws of photochemistry"

2¾

b) An electron in a one dimensional metal length of L is describe by the wavefunction $\psi(x) = Sin\left({}^{\pi x}/_{L}\right)$. Compute the expectation value (<p>) of the momentum of the electron.

4

c) The molar absorption coefficient of a solute at 440 nm is 423 dm^3 mol^{-1} cm^{-1}. When light of that wavelength passes through a 6.50 mm cell containing a solution of the solute, 48.3 percent of the light is absorbed. What is the molar concentration of the solute?

4

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

(i) H_2O
(ii) H_2O_2
(iii) C_2H_4

4

e) Which of the following function is the eigen function of the $\frac{d^2}{dx^2}$

(i) $Sin\frac{n\pi x}{L}$ (ii) e^{imx}

Give the eigen values where appropriate

4

Q.5.

a) What are the photochemical and thermal reactions; give examples of each?

2¾

b) Write down the expression for the following operators:

(i) $\left(\frac{d}{dx} + x\right)^2$

(ii) $\left(\frac{d^2}{dx^2} - 2x\frac{d}{dx} + 1\right)^2$

4

c) Give the answer of followings for a diatomic molecule undergoing Simple Harmonic motion

(i) Write the expression for Zero-point energy.
(ii) Sketch the Vibrational energy levels and allowed transition between them.

4

d) Which of the following molecules may show rotational and vibrational spectra and why?
(i) H_2 (ii) HCl (iii) CO_2 (iv) H_2O

4

e) What is quantum yield? What are the reason behind its low and high quantum yields?

4

Q.6.

a) Explain "Born-oppenheimer approximation".

2¾

b) Describe the fluorescence. What is the reason that the fluorescence spectrum observed always at lower wavelength than the Phosphorescence?

4

c) What is the condition of normalization for any wavefunction? find out whether the following wavefunction is Normalized or not?

$\psi_3 = Sin\ \frac{3\pi x}{l} \quad 0 \leq x \leq l$

4

d) The spacing of lines in the microwave spectrum of $^{27}Al^{1}H$ is 12.604 cm^{-1}. calculate moment of inertia and bond length of the molecule

4

e) Determine the commutators of the following operators:

(i) $\frac{d}{dx}$ and $\frac{1}{x}$

(ii) $\frac{d}{dx}$ and x^2

4