(c) Solve Schrodinger wave equation for a particle of mass 'm' moving in 1-D box of length '1'. Calculate the ground state energy (in kJ mol^{-1}) for an electron that is confined to a one-dimensional infinite potential well with a width of 0.2 nm. (3.5,4,5)

4. (a) The fundamental vibrational frequency of HCl molecule is found to be 2,890 cm^{-1}. Calculate the force constant of the molecule. The atomic masses are $^{1}H = 1.673 \times 10^{-27}$kg; $^{35}Cl = 58.06 \times 10^{-27}$ kg. What will be the value of zero point energy for the same?

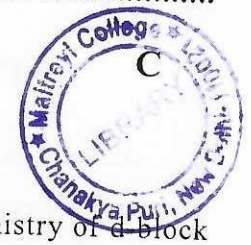
(b) What is meant by the terms Chromophores and Auxochromes? Give suitable examples.

(c) Calculate the average value of p_x for a particle in a one-dimensional box of length a. (4.5,4,4)

6 Dec

[This question paper contains 8 printed pages.]

06 DEC 2022 **Your Roll No.....**



Sr. No. of Question Paper : 1519

Unique Paper Code : 42177925

Name of the Paper : DSE – Chemistry of d-block Elements, Quantum Chemistry and Spectroscopy

Name of the Course : **B.Sc. Program**

Semester : V

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **six** questions in total with **three** from **SECTION A** and **three** from **SECTION B**.
3. Attempt **SECTION A** and **SECTION B** on separate answer sheets.
4. Use of scientific calculator and Log table is allowed.

P.T.O.

SECTION A

INORGANIC CHEMISTRY

Attempt **ANY THREE** questions. Attempt **any three** questions in this section. **All** questions carry equal marks.

1. (a) Name any three of the following complexes according to the IUPAC system of nomenclature :

   (i) $K_3[Al(C_2O_4)_3]$

   (ii) $[Co(NH_2)_2(NH_3)_4]Br$

   (iii) $[Co(NH_3)_6]\ [CuCl_5]$

   (iv) $[(NH_3)_2Pt(Cl).(Cl)Pt(NH_3)_2]Cl_2$

   (b) Indicate the isomerism exhibited in the following pairs of compounds and give one method to distinguish between them :

   (i) $[Co(NH_3)_4\ Cl_2]NO_2$ and $[Co(NH_3)_4(Cl)NO_2]Cl$

   (ii) $[Cr(H_2O)_5Cl]Cl_2.H_2O$ and $[Cr(H_2O)_6]Cl_3$

2. (a) In photo-bromination of cinnamic acid, a radiation of wavelength 435.8 nm with an intensity of $1.4 \times 10^{-3}\ Js^{-1}$ was 80% absorbed in a litre of the solution during ah exposure of 1105 seconds. The concentration of Br_2 is decreased by 7.5×10^{-5} moles/litre. Calculate the quantum yield of the reaction.

   (b) Prove that the wave functions of a particle in a one-dimensional box are normalized.

   (c) What is the essential condition for obtaining a microwave spectrum? Which of the following molecules will be microwave active: H_2, HCl, CO, CH_3Cl? (4.5,4,4)

3. (a) What is zero point energy for a particle in one dimensional box? Is the occurrence of zero point energy in accordance with Heisenberg's uncertainty principle?

   (b) With the help of a suitable diagram, explain the process of fluorescence.

(ii) $[CoF_6]^{3-}$ (4.5,4,4)

SECTION B

Planck's constant, $h = 6.626 \times 10^{-34}$ Js;

Velocity of light, $c = 3 \times 10^8 ms^{-1}$

Mass of an electron, $m_e = 9.1 \times 10^{-31}$ kg

Attempt **any three** questions.

1. (a) State Lambert Beer's law. A substance when dissolved in water at 10^{-3} molar concentration absorbs 10% of the incident radiation in a cell of path length 1 cm. What should be the concentration of the solution in order to absorb 90% of the same radiation?

(b) Discuss the effect of isotopic substitution on microwave spectrum of diatomic molecules. The rotational constant for $H^{35}Cl$ is observed to be 10.59 cm^{-1}. What are the values of B for $H^{37}Cl$.

(c) Explain the difference between internal conversion and intersystem crossing. (4.5,4,4)

(c) Give brief reasons for **any two** of the following :

(i) The densities of the metals of the third transition series is almost twice that of the corresponding metals of the second transition series.

(ii) An aqueous solution of copper sulphate is blue while that of zinc sulphate is colourless.

(iii) Ca & Sc^+ are isoelectronic but have different electronic configuration.

(4.5,4,4)

2. (a) Write the formulae of **any three** of the following according to IUPAC convention :

(i) μ-oxidobis{pentaamminechromium(III)} ion

(ii) Hexaamminechromium(III) pentacyanidocuprate(II)

(iii) Tetraamminchloridomanganese(III) nitrate

(iv) Caesium tetrafluoridooxidochromate(III)

(b) Why is $TiCl_3$ coloured while TiO_2 is colourless? Can this reason explain the colour of $KMnO_4$? If not, then assign the reason.

P.T.O.

(c) Predict the appropriate choice and give brief reasons :

(i) Greater Stability Ti(IV), Ti(III)

(ii) Higher number of oxidation states Mn Fe

(4.5,4,4)

3. (a) The complex $[Co\ Cl_2\ (en)_2]^+$ exists in two isomeric forms A & B. A is optically active where as B is optically inactive. Draw the structures of A & B and explain briefly.

(b) State Jahn Teller theorem. Giving suitable reason, explain which of the following complexes will be distorted.

$[Fe(H_2O)_6]^{3+}$ or $[Cr(H_2O)_6]^{2+}$

(c) Calculate CFSE in terms of Δ_t of a d^4 metal ion placed in a tetrahedral field. Draw the splitting diagram. (4.5,4,4)

4. (a) For Mn^{3+} ion, the electron pairing energy, P is 28000 cm^{-1}, Δ_0 values for the complexes $[Mn(H_2O)_6]^{3+}$ and $Mn(CN)_6]^{3-}$ are 21000 cm^{-1} and 38500 cm^{-1}, respectively. Do these complexes have low spin or high spin configuration? Calculate CFSE for both the configurations to justify your answer.

(b) Given below is the Latimer diagram for Manganese :

OS	(VI)		(V)		(IV)		(III)		(II)
	Mn	1.28 V →	Mn	2.9 V →	Mn	0.9 V →	Mn	1.5 V →	Mn

Answer the following questions :

(i) Giving suitable reason, identify oxidation states which will disproportionate

(ii) Calculate the skip step potential for Mn(VI) ----- Mn(IV)

OR

(b) Briefly discuss **any two** of the following :

(i) Lanthanoid Contraction and its consequences.

(ii) Inner and outer orbital complexes

(iii) Complex formation tendency of d - block elements.

(c) Using VBT predict the geometry and magnetic behaviour of :

(i) $[Co(NH_3)_6]^{3+}$