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.

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.
4. Each Question carries equal marks.
5. First part of each question carries 0.75 marks.
6. Remaining parts of each question carry 6 marks
7. Attempt all parts of a question together.

SECTION A

Q1**.**

(a) Zinc does not show variable oxidation state because of …….

(b) Explain with reasons any three:
   (i) Co^{3+} and Ni^{3+} are unstable while Fe^{3+} is stable
   (ii) Transition metals in their higher oxidation state act as strong oxidizing agents while in their lower oxidation states act as reducing agent.
   (iii) Ferric salts are more stable than the corresponding ferrous salts.
   (iv) MnO_2 is basic whereas Mn_2O_7 is acidic

(c) What is d-d transition? Mention the different factors responsible for exhibiting colour in complexes of transition elements.

(d) What is the most stable oxidation state of lanthanides? In which case these elements show +2 and +4 oxidation states? Also explain why Lanthanides do not resemble transition elements in complex formation.

Q2.

(a) Ionization isomer for [Co $(NH_3)_5SO_4$] Br is ……

(b) Write the formula of the following:

(i) diaquodiiododinitritopalladium (IV)
(ii) tris (ethylenediamine) cobalt (III) sulphate
(iii)μ-hydroxo-μ-imido bis[bisethylene] diamine cobalt (III) nitrate
(iv)pentacarbonyltriphenylphosphinechromium (0)
(v) chlorocyanonitrotriaminecobalt (III)
(vi)octaamine-μ-amido-μ-nitrodicobalt (II) nitrate

(c) Calculate crystal field splitting energy (CFSE) of tetrahedral and octahedral complexes with configuration d^5 and d^6 in weak and strong ligand field.

(d) Explain why (any three):
(i) [Cu $(CN)_4]^{2-}$ is square planar while $[Cucl_4]^{2-}$ is tetrahedral.
(ii) Square planar structure is more stable than octahedral.
(iii)Tetrahedral complexes are generally high spin.
(iv)$[CoF_6]^{3-}$ is paramagnetic while [Co $(NH_3)_6$ is diamagnetic.

Q3.

(a) Linkage isomer of [Co $(NH_3)_5$ (ONO) Cl_2 is ……..

(b) Describe in detail d-orbital splitting in square planar complexes. Explain why the crystal field splitting in tetrahedral complexes is just opposite to octahedral complexes.

(c) What is Jahn Teller effect? Why distortion is found in octahedral complexes? Explain with examples

(d) What is the effect of nature of ligand on Δ_O. Determine the number of unpaired electrons and CFSE for

(i) [Fe $(H_2O)_6]^{3+}$
(ii) [Cr $(NH_3)_6]^{3+}$

Section B

Physical Constants

Planck's constant 6.626 x 10^{-34} *Js*

Velocity of light 3 x 10^8 *m/s*

Atomic mass unit 1.661 x 10^{-27}*kg*

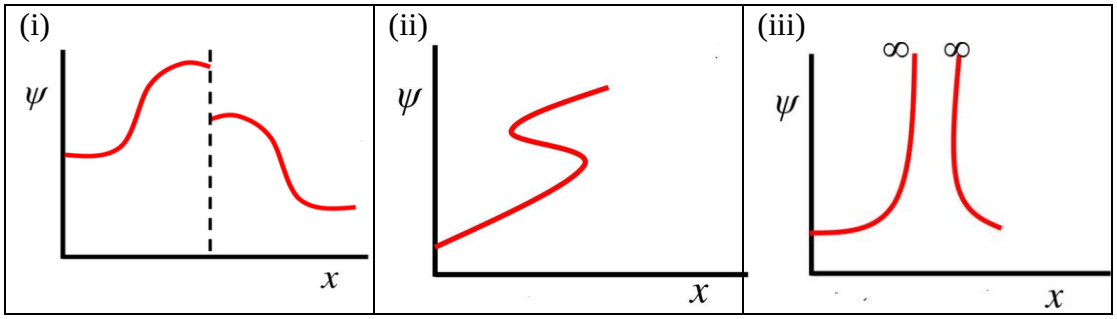
Avogadro's number 6.023 x 10^{23} mol^{-1}

Mass of electron 9.109 x 10^{-31} *kg*

Q4

(a) The square of the magnitude of the wave function is called _____.

(b) The following figure shows three wave functions in the region $x > 0$. Indicate and explain for each wave function whether the wave function is an acceptable or unacceptable wave function.



(c) Define eigen value. Which of the following functions are eigen functions of d^2/dx^2:

(i) Sin 3x

(ii) $5x^2$

Give the eigen value wherever appropriate.

(d) Solve Schrödinger wave equation for a particle of mass 'm' moving in 1-D box of length 'l'. 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.

Q5

(a) The emission of light as a result of chemical action is called _____.

(b) An aqueous solution of $KMnO_4$ gives maximum absorbance at 310 nm. Find the value of radiation in

(i) J $molecule^{-1}$,

(ii) kJ mol^{-1},

(iii) cm^{-1}

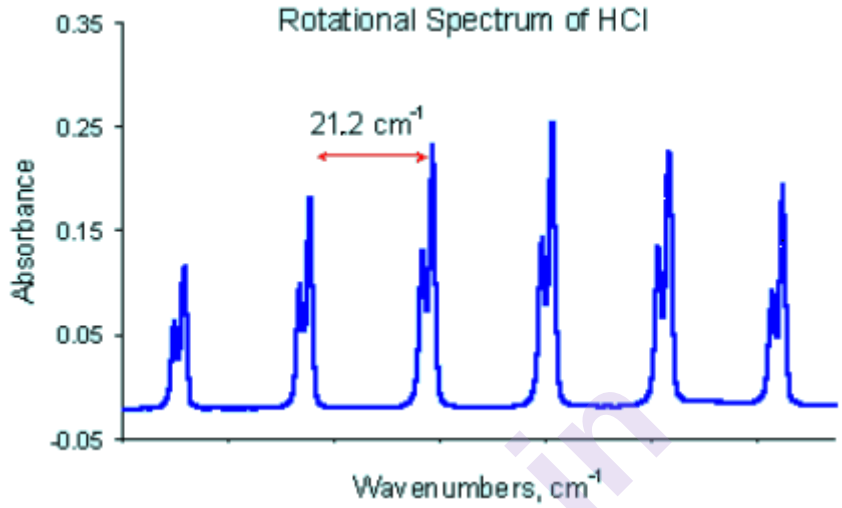
(c) Distinguish between the primary and secondary process in a photochemical reaction. How does the distinction permit the explanation of quantum yield of 2 in the dissociation of HI?

(d) The drug Tolbutamine (molar mass = 270) has a molar absorptivity of 703 at 262 nm. One tablet is dissolved in water and diluted to a volume of 2L. If the resulting solution (taken in a cell of 1 cm) exhibits an absorbance equal to 0.687 at 262 nm, how many grams Tolbutamine are contained in the tablet?

Q6

(a) Selection rule for microwave spectroscopy is _____.

(b) From the following rotational spectrum of $^{1}H^{35}Cl$, find the bond length of the H-Cl.



How would substitution of ^{35}Cl by ^{37}Cl alter the microwave spectrum of $^{1}H^{35}Cl$?

(c) State the conditions for a molecule to be rotationally and vibrationally active. Which of the following molecules will give rise to observable rotational and vibrational spectra HCl, N_2, CO, H_2O?

(d) The force constant of HF molecule is 970 Nm^{-1}. Calculate the fundamental vibrational frequency as well as the zero-point energy.