CHEMISTRY - II
(CHEM 2201)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) What type of isomerism is shown by the following pair of complex compound?
$[Co(NH_3)_5Br]SO_4$ and $[Co(NH_3)_5\ SO_4]Br$
(a) Optical (b) Linkage (c) Coordination (d) Ionization.

(ii) Identify the compound with the highest ring strain.
(a) Cyclohexane (b) Cyclopropane (c) Cyclopentane (d) Cyclobutane

(iii) The rotational contribution of a non linear polyatomic molecule towards the heat capacity of the molecule is
(a) kT (b) 3/2 kT (c) ½ kT (d) 2 kT

(iv) The CFSE for the ion $[Ti(H_2O)_6]^{3+}$ is
(a) −4Dq (b) −6Dq (c) 8Dq (d) 10Dq

(v) The d-electronic configuration of the metal ion in the complex $[Mn(CN)_6]^{4-}$ is
(a) $e^4t_2^1$ (b) $e^2t_2^3$ (c) $t_{2g}^3e_g^2$ (d) $t_{2g}^5e_g^0$

(vi) Gauche conformation of n-butane is less stable than anti conformation due to
(a) Hydrogen bonding (b) Covalent bonding
(c) Vander Waal's repulsion (d) Torsional strain

(vii) A lyotropic series comprise
(a) Atoms with increasing Bohr radius
(b) Ions with increasing coagulating power
(c) Molecules increasing absorptivity
(d) Atoms with increasing ionization potential.

(viii) Which of the following polymer is used to make the rechargeable batteries?
(a) Polyaniline (b) Polypyrrole
(c) Polyacrylonitrile (d) Polyester.

(ix) Which cyclohexane conformation has the highest energy?
(a) Chair (b) Boat (c) Half chair (d) Twist boat.

(x) The increasing order of magnitude of the most probable speed (C_{mp}), average speed (C_{av}) and root mean square speed (C_{rms}) is as follows
(a) $C_{rms} > C_{av} > C_{mp}$ (b) $C_{av} > C_{rms} > C_{mp}$
(c) $C_{mp} > C_{av} > C_{rms}$ (d) $C_{av} > C_{mp} > C_{rms}$

Fill in the blanks with the correct word

(xi) What simple axis of symmetry (n=?) presents in the boat form of cyclohexane _____.

(xii) Considering the four electrolytes, $FeCl_3$, $MgSO_4$, $NaNO_3$ and $CaCl_2$, the most efficient one for the coagulation of a negative sol is _____.

(xiii) Iron–sulphur proteins function as _____ carriers in biological redox reactions.

(xiv) A weak field ligand produces a _____ spin complex.

(xv) The temperature at with rms speed of CO_2 (molar mass=44) will be double of its value at 27 °C is _____.

Group - B

2. (a) Write without derivation the Maxell expression for the probability that a molecule will have, the u-component velocity between u and (u+du) and derive the expression for the average velocity in x-direction, $\bar{\varepsilon}_x$, considering the average value of the total kinetic energy as 3/2kT. State the principle of equipartition of energy. *[(CO1/IOCQ)]*
(b) Discuss the origin of charge on a colloidal particle. *[(CO2/LOCQ)]*
(c) Calculate the value of delocalization energy of butadiene (without derivation) using the values of HMOs energies. *[(CO2/IOCQ)]*

5 + 4 + 3 = 12

3. (a) Set up the Schrodinger equation for the hydrogen like atom in spherical coordinates and show that this equation can be separated into radial part and angular part. What quantum numbers are introduced by solving the angular part of the solution of the equation? *[(CO2/IOCQ)]*
(b) State and proof variational theorem. *[(CO2/LOCQ)]*

(3 + 3 + 2) + 4 = 12

Group - C

4. (a) Draw all the possible isomers of dichloro bis(ethylenediamine)platinum(IV). Which of these isomers will be optically inactive and why? *[(CO1/LOCQ)]*
(b) Why low-spin tetrahedral complexes are not known? *[(CO1/IOCQ)]*
(c) On the basis of CFT find the value of spin-only magnetic moment of $K_4[Mn(CN)_6]$. *[(CO1/IOCQ)]*

(d) Write the formula of Zeise's salt. Draw and explain the structure of the compound. *[(CO3/IOCQ)]*

4 + 2 + 3 + 3 = 12

5. (a) Write the IUPAC names of the following complex compounds: $[Co(NH_3)_6][Cr(CN)_6]$, $Li[AlH_4]$ *[(CO1/LOCQ)]*

(b) Illustrate 'coordination isomerism' taking a suitable example. *[(CO1/LOCQ)]*

(c) Calculate Crystal Field Stabilization Energy (CFSE) for a d^5 system in low spin and high spin octahedral crystal field. *[(CO3/IOCQ)]*

(d) What is 18-electron rule? Anionic $[Mn(CO)_5]^-$ is more stable than neutral $[Mn(CO)_5]$ molecule – Justify using 18-electron rule. *[(CO3)(Understand/LOCQ)]*

2 + 2 + (2 + 2) + (1 + 3) = 12

Group - D

6. (a) Draw and explain the structure of cis 1-4 ditertiarybutylcyclohexane in its most stable conformation. *[(CO5/LOCQ)]*

(b) Write a short note on Pitzer strain. *[(CO5/LOCQ)]*

(c) Draw with proper labelling the energy profile diagram for the flipping of chair conformation of cyclohexane. Why the boat conformation of cyclohexane is less stable than twist boat? *[(CO5/IOCQ)]*

(d) Write down the expected products when trans-1-bromo-2-methylcyclohexane is treated with sodium ethoxide in presence of ethanol. Discuss stereochemically the formation of the actual product. *[(CO5/IOCQ)]*

(1 + 1) + 2 + (2 + 2 + 1) + (2 + 1) = 12

7. (a) Define Phase transfer catalyst (PTC). Explain phase transfer catalysis reaction with suitable example. *[CO1/LOCQ)]*

(b) Compare dipole moment of cis and trans 1, 2 dibromo cyclohexane. *[CO1/LOCQ]*

(c) Draw the preferred chair conformations of cis and trans 1, 3 dimethylcyclohexane also indicate their optical properties considering symmetry elements. *[CO6/IOCQ]*

(d) Cis- and trans-2-Chlorocyclohexanol behave differently towards alkali — Explain. *[CO6/IOCQ]*

(2 + 1) + 2 + (2 + 2) + 3 = 12

Group - E

8. (a) What is Wilson's disease? How it can be removed using chelation therapy? *[(CO4/LOCQ)]*

(b) Write the disadvantages and uses of polyaniline. *[(CO1/LOCQ)]*

(c) Derive the Langmuir adsorption equation stating the assumption involved? *[(CO6/IOCQ)]*

(1 + 2) + (2 + 2) + (4 + 1) = 12

9. (a) Draw the active site structure of 2Fe-2S ferredoxin. What are the oxidation states of the metal ion present in the metalloenzyme? *[(CO4/LOCQ)]*

(b) What are surface films on liquids? Show how the surface film pressure varies with film area. *[(CO6/LOCQ)]*

(c) Explain the formation of novolac. Mention its uses. *[CO1/LOCQ]*

4 + 4 + (3 + 1) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	50	50	0

Course Outcome (CO):

After the completion of the course students will be able to

1. Firm knowledge in the advances of inorganic, organic and physical chemistry. They will get an understanding of the theoretical principles underlying molecular structure, bonding and properties.
2. Knowledge of understanding the quantum mechanics makes students to learn illustrative case studies that organize molecular modelling for designing of reactors and derivation of thermo-chemical functions.
3. Ability to identify and formulate different types of complexes can be of further use in dye and pigment industry. Organo-metallic chemistry will provide clear idea on transition metal catalysis which has wide industrial and biological applications.
4. Understanding of the role of transition metal in living cell will be introduced through the knowledge of bioinorganic chemistry has tremendous scope in future research.
5. Knowledge in the fundamental concepts of structure and reactivity of alicyclic and acyclic organic molecules has important applications in pharmaceuticals industries and natural product synthesis.
6. Studies on adsorption isotherms can develop the concept of heterogeneous catalysis widely applied in oil refinery and petroleum industry.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*