

CHEMISTRY II
(CHEM 2201)

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

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

Group - A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) The possible number of modes of vibration of CH₄ (non linear) is
(a) 18 (b) 9 (c) 15 (d) 12.
- (ii) The temperature at which the r.m.s. speed of SO₂ (M=64) be the same as that of O₂(M=32) at 27°C is
(a) 327°C (b) 54°C (c) 13.5°C (d) 108°C.
- (iii) What type of isomerism is shown by the following pair of complex compound [Co(NH₃)₅Br]SO₄ and [Co(NH₃)₅SO₄]Br
(a) Optical (b) Linkage
(c) Coordination (d) Ionic.
- (iv) The favoured conformation (Gauche, anti or eclipsed) for the molecules 1, 2 dichloro ethane and 1, 2 ethanediol will be respectively
(a) Gauche, anti (b) Eclipsed, gauche
(c) Anti, gauche (d) Anti, anti.
- (v) Goitre is caused by the deficiency of
(a) Copper (b) Iodine (c) Calcium (d) Iron.
- (vi) Which of the following statements is wrong?
(a) Hemoglobin is more oxygenated at higher oxygen pressures
(b) Myoglobin is more oxygenated at lower oxygen pressures
(c) Hemoglobin is less oxygenated at lower oxygen pressures
(d) Myoglobin is more oxygenated at higher oxygen pressures.
- (vii) The advantage of using conducting polymers in place metals is their
(a) cost (b) light-weight
(c) thermal conductivity (d) solubility.
- (viii) The complex which has no d-electron in the central metal ion is
(a) [MnO₄]⁻ (b) [Ni(H₂O)₆]²⁺ (c) [Cr(H₂O)₆]³⁺ (d) [Fe(CN)₆]⁴⁻.

- (ix) In boat conformation of cyclohexane, the most destabilizing interaction is____
(a) 1, 3-diaxial (b) 1,3-diequatorial
(c) Flagpole-Flagpole (d) Eclipsing.
- (x) Of the four ions Mg^{2+} , Al^{3+} , Cl^- and SO_4^{2-} , the most effective one for the coagulation of a negatively charged sol is
(a) Cl^- (b) Mg^{2+} (c) SO_4^{2-} (d) Al^{3+} .

Group- B

2. (a) Derive the expression for the average kinetic energy in the x-direction and assuming the total kinetic energy of a molecule as $(3/2)kT$, state the principle of equipartition of energy. [[CO1](Apply/IOCQ)]
(b) Discuss the origin of charge on a colloidal particle. [[CO2](Analyse/IOCQ)]
(c) Write down the expression for the Hamiltonian operator of Helium atom in the atomic unit and explain the terms involved in the expression. [[CO2](Remember/LOCQ)]
6 + 3 + 3 = 12
3. (a) Derive the expression for the average root mean square speed of a molecule using without derivation, the Maxwell speed distribution formula. [[CO1]/LOCQ]
(b) Illustrate with the example of preparation of AgI sol, how the sol becomes charged with positive and negative charge? How is the nature of the charge detected by electrophoretic measurement? [[CO1]/IOCQ]
(c) Use the Hückle molecular orbital method for the calculation of π -MO's of ethylene molecule. [[CO1]/LOCQ]
4 + 4 + 4 = 12

Group - C

4. (a) Sketch the possible geometrical isomers of $[Pt(NH_3)_2Cl_2]$. Why tetrahedral complexes are unable to exhibit geometrical isomerism. [[CO1]/LOCQ]
(b) The value of observed magnetic moment of $[Ni(H_2O)_6]Cl_2 = 2.9$ BM-Explain. [[CO1]/IOCQ]
(c) The Δ_o value of $[Mn(H_2O)_6]^{3+}$ is found to be $21,000cm^{-1}$. The pairing energy of Mn(III) is $28,000cm^{-1}$. Predict with reason whether the given complex ion is high spin or low spin. [[CO1]/HOCQ]
(d) Explain using diagram the 'Synergic effect' in the formation of terminal metal-carbonyl bond. [[CO3]/IOCQ]
(2 + 2) + 3 + 2 + 3 = 12
5. (a) Write using IUPAC rules, the names of the following complex compounds: $K[Co(CO)_4]$, $[Co Br(NCS)(en)_2]Cl$. [[CO3](Remember/LOCQ)]
(b) Draw a labelled diagram to show splitting of degenerate d-orbitals in the tetrahedral crystal field for the ion $[FeCl_4]^{2-}$ and calculate the CFSE of the complex ion. [[CO3](Analyse/IOCQ)]

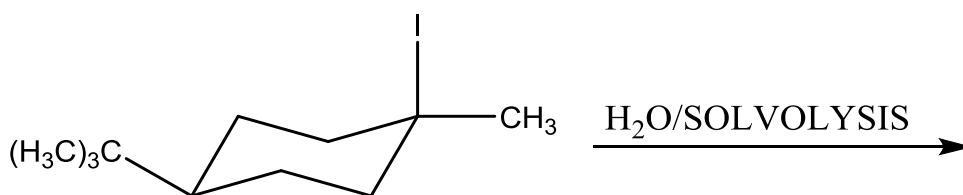
- (c) $[\text{CoF}_6]^{3-}$ is paramagnetic while $[\text{Co}(\text{CN})_6]^{3-}$ is diamagnetic –explain on the basis of CFT. [[CO3](Evaluate/HOCQ)]
- (d) Draw two structures of $\text{Co}_2(\text{CO})_8$ to show two different modes of bonding in it and also show in each case it satisfies the 18- electron rule. [[CO4](Understand/LOCQ)]
- 2 + 3 + 4 + 3 = 12**

Group - D

6. (a) Draw the diastereomers of 1-bromo-1,2 diphenylpropane. Which one of these reacts at a faster rate towards base induced elimination? Explain mechanistically. [[CO5](Apply/IOCQ)]
- (b) Explain why the halogens (F, Cl, Br and I) do not differ much in their preference for the equatorial position. [[CO5](Understand/LOCQ)]
- (c) Explain with mechanism why the solvolysis of cis 4-tert butylcyclohexyl tosylate reacts faster than its trans isomer although both of them involved the same transition state. [[CO5](Evaluate/HOCQ)]
- (d) What is the relation between I and II? [[CO5](Analyse/IOCQ)]

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

7. (a) What is crown ether? Write the structure of 18-crown-6 and its role in the reaction of $\text{CH}_3(\text{CH}_2)_6\text{CH}_2\text{Br}$ with KF in warm benzene. [[CO5]/LOCQ]
- (b) Write the structure for the alcohol (alcohols) that you would expect from the following reaction indicating intermediate state and analyse the fact: [[CO5/IOCQ]]



- (c) Trans-2-aminocyclohexanol on treatment with aqueous NaNO_2 and dil HCl gives cyclopentane carboxaldehyde while its cis-isomer gives mixture of products- Explain. [[CO5]/HOCQ]
- (d) Trans-1, 2-diaxialcyclohexane halohydrine undergoes epoxidation several times faster than diequatorial isomer. Explain. [[CO5]/IOCQ]
- (2 + 1 + 1) + 3 + 3 + 2 = 12**

Group - E

8. (a) Derive the Gibbs adsorption equation and discuss how this can explain the variation of surface tension of a solvent with the change of concentration of a surface active solute. [[CO6]/LOCQ]

- (b) For oxygen binding to hemoglobin, the value of successive binding constant increases ($K_1 < K_2 < K_3 < K_4$)-Explain. [[CO4]/HOCQ]]
- (c) What is chelation therapy? Write a brief account on the “use of metal complexes as anticancer drugs”. [[CO4]/LOCQ]]
- (5 + 1) + 3 + (1 + 2) = 12**
9. (a) Draw the active site structure of 2Fe-2S ferredoxins. What are the oxidation states of the metal ion present in the metalloenzyme? [[CO4](Apply/IOCQ)]
- (b) The surface tension of a dilute solution of a solute varies linearly with the solute concentration, c_2 as $\gamma = \gamma_0 - ac_2$ where, γ_0 is the surface tension of the solvent and ‘a’ is constant. Show that the surface excess $\Gamma = (\gamma_0 - \gamma) / RT$. [[CO2](Analyse/IOCQ)]
- (c) What is Bakelite? How is it formed? What are the applications of Bakelite? [[CO1](Remember/LOCQ)]
- (2 + 2) + 4 + (1 + 2 + 1) = 12**

<i>Cognition Level</i>	<i>LOCQ</i>	<i>IOCQ</i>	<i>HOCQ</i>
<i>Percentage distribution</i>	40.62	46.87	12.51

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.*