

**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) Consider two gases A and B. The molar mass of B is four times that of A. The temperature at which the rms speed of B will be same as that of A at 27°C is  
(a) 54°C                      (b) 108°C                      (c) 927°C                      (d) 13.5°C.
- (ii) Bakelite is \_\_\_\_\_  
(a) Elastomer                      (b) Fibre                      (c) Thermoplastic                      (d) Thermosetting.
- (iii) Number of possible modes of vibration of the nonlinear CH<sub>4</sub> molecule is  
(a) 9                      (b) 10                      (c) 12                      (d) 13.
- (iv) Which of the following is the highest energy conformation of cyclohexane?  
(a) Chair                      (b) Half-chair                      (c) Boat                      (d) Twisted boat.
- (v) The oxidation number of cobalt in K<sub>3</sub>[Co(CN)<sub>6</sub>] is  
(a) 0                      (b) 1                      (c) 2                      (d) 3.
- (vi) The reaction  $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br} + ^-\text{OEt} \rightarrow \text{CH}_3\text{CH}=\text{CH}_2 + \text{Br}^-$  Is one kind of  
(a) Substitution reaction                      (b) Addition reaction  
(c) Elimination reaction                      (d) Rearrangement reaction.
- (vii) Which of the following is paramagnetic?  
(a) [Ni(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup>                      (b) [Zn(NH<sub>3</sub>)<sub>4</sub>]<sup>2+</sup>                      (c) Ni(CO)<sub>4</sub>                      (d) [Co(NH<sub>3</sub>)<sub>6</sub>]<sup>3+</sup>.
- (viii) The most weak field ligand in the spectrochemical series is  
(a) Cl<sup>-</sup>                      (b) F<sup>-</sup>                      (c) NO<sub>2</sub><sup>-</sup>                      (d) CN<sup>-</sup>.
- (ix) The spin magnetic moment of iron in the complex K<sub>4</sub>[Fe(CN)<sub>6</sub>] is  
(a)  $\sqrt{3}$  BM                      (b)  $\sqrt{8}$  BM                      (c)  $\sqrt{5}$  BM                      (d) 0 BM.
- (x) The high temperature limiting value of molar heat capacity of nonlinear SO<sub>3</sub> is  
(a) 12R                      (b) 6R                      (c) 13/2RT                      (d) 9R.

**Group- B**

2. Write, without derivation, Maxwell's expression for speed distribution and obtain the expression for the fraction of the total number of molecules having kinetic energy higher than a minimum value  $\epsilon'$ . Explain its significance. [(CO1/IOCQ)]  
(1 + 9 + 2) = 12
3. (a) What are protective colloids? What is meant by the term gold number? [CO1, LOCQ]
- (b) Set up the Schrodinger equation for the hydrogen atom in spherical coordinates and show that this equation can be separated into radial part and angular part. Which quantum numbers are introduced by solving the radial and angular part of the equation? [CO2, HOCQ]  
(2 + 2) + (2 + 3 + 3) = 12

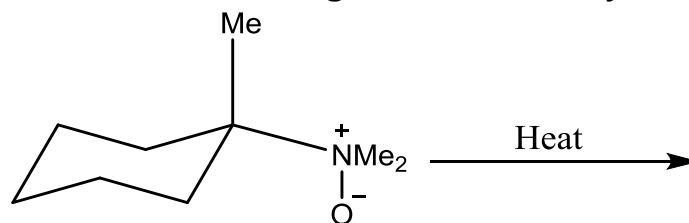
**Group - C**

4. (a) Predict the reason behind greater stability of  $\text{Co}^{3+}$  complexes than  $\text{Co}^{2+}$  in strong field octahedral environment. [(CO1/IOCQ)]
- (b) Compare the magnetic behaviour of the complex entities  $[\text{Fe}(\text{CN})_6]^{4-}$  and  $[\text{FeF}_6]^{3-}$  using crystal field theory. [(CO3/HOCQ)]
- (c) Write the chemical formula of Zeise's salt using IUPAC rule. [(CO3/IOCQ)]
- (d) Illustrate with an example each of the following:  
(i) Ionization isomerism  
(ii) linkage isomerism. [(CO1/LOCQ)]  
3 + 3 + 2 + (2 + 2) = 12
5. (a) Absorption maxima for the complex ion  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$  obtained at  $20300\text{cm}^{-1}$ . Predict with proper justification where the absorption maxima will shift for the complexes  $[\text{Ti}(\text{CN})_6]^{3-}$  and  $[\text{TiCl}_6]^{3-}$  ions, respectively. [CO3, IOCQ]
- (b) What do you mean by synergic effect related to metal carbonyls? [CO3, LOCQ]
- (c) Draw the structures of possible optical isomers of  $[\text{Co}(\text{en})_3]^{3+}$ . [CO3, IOCQ]
- (d) What is effective atomic number rule for stability of metal complexes? Using this rule compare the stability of  $[\text{Fe}(\text{CN})_6]^{4-}$  and  $[\text{Fe}(\text{CN})_6]^{3-}$ . [CO3, IOCQ]  
(2 + 2) + 3 + 2 + (1 + 2) = 12

**Group - D**

6. (a) Draw the preferred chair conformations of cis and trans 1, 3 dimethyl cyclohexane. Indicate in both cases their optical properties considering symmetry elements present. [IOCQ, CO5]
- (b) Discuss while reaction between cis-2-chlorocyclohexanol with aqueous alkali gives cyclohexanone, whereas trans isomer gives cyclohexene oxide. [IOCQ, CO5]
- (c) Compare the dipole moment of cis and trans 1,2-dibromocyclohexane. [IOCQ, CO5]

- (d) Find the products of the following reaction. Identify the major product.



[IOCQ, CO5]

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

7. (a) Draw with proper labelling the energy profile diagram for the flipping of chair conformation of cyclohexane. [(CO5/LOCQ)]
- (b) Draw the conformational isomers of 1, 2 Dichloroethane in Newman projection formula. Identify the most stable conformation. [(CO5/IOCQ)]
- (c) What is phase transfer catalyst? Explain phase transfer catalysis with a suitable example mentioning reaction. [(CO5/IOCQ)]
- (d) Discuss the symmetry elements present in the boat conformation of cyclohexane. [(CO5/HOCQ)]
- (e) Why are vinyl and aryl halides unreactive in  $S_N1$  and  $S_N2$  reaction? [(CO5/IOCQ)]
- $$2 + (1 + 1) + (2 + 1) + (2 + 1) + 2 = 12$$

### Group - E

8. (a) What is the basic difference between thermoplastic and thermosetting polymers. What is novolacs and how it form? [(CO1/LOCQ)]
- (b) Derive thermodynamically the Gibbs adsorption equation. [(CO6/IOCQ)]
- (c) What are the effects of iodine deficiency in human beings? [(CO4/IOCQ)]
- (d) Draw the structure of myochrysim mentioning its use. [(CO4/LOCQ)]
- $$(1 + 2) + 4 + 2 + (2 + 1) = 12$$
9. (a) What is chelation therapy? How it works? What are the risks of chelation therapy? [LOCQ, CO4]
- (b) Write the uses and side effects of Ibuprofen. [LOCQ, CO5]
- (c) Give a brief account of Poly(acetylene). [LOCQ, CO5]
- (d) Stating the important assumptions, derive the Langmuir Adsorption Isotherm in experimentally verified form. [IOCQ, CO6]
- $$(1 + 1 + 2) + 2 + 2 + 4 = 12$$

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	28.13	57.29	14.58

**Course Outcome (CO):**

After the completion of the course students will have

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