

CHEMISTRY II
(CHM2201)

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

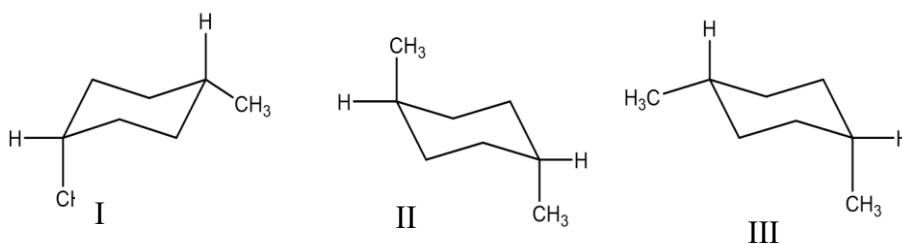
1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) Lyophilic colloids are normally
(a) Reversible colloids (b) Irreversible colloids
(c) Aerosol (d) Solid gel
- (ii) The high temperature limiting value of molar heat capacity of CO₂
(a) 6RT (b) 5/2RT (c) 6.5R (d) 13/2RT
- (iii) The 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) Ionisation
- (iv) The CFSE for the ion [Ti(H₂O)₆]³⁺ is
(a) -4Dq (b) -6Dq (c) 8Dq (d) 10Dq
- (v) The number of ions present in K₃[Fe(CN)₆] are
(a) 10 (b) 4 (c) 3 (d) 2
- (vi) Which of the following is the highest energy conformation of cyclohexane?
(a) Chair (b) Half chair (c) Boat (d) Twist boat
- (vii) The equilibrium constant equals to 1 for the interconversion of the two chair conformations of a dimethyl cyclohexane when the methyl groups are in which positions?
(a) Both are equatorial (b) Both are axial
(c) One is axial and the other is equatorial (d) Both are pseudo-equatorial
- (viii) A surfactant
(a) Reduces the surface tension of the solvent
(b) Increases the surface tension of the solvent
(c) Reduces the surface tension of the solution
(d) Increases the surface tension of the solution

- (ix) In the active site structure of deoxyhaemoglobin the fifth position is occupied by
 (a) Lysine (b) Leucine (c) Histidine (d) Valine
- (viii) Which of the following structures represent cis-1,4-dimethylcyclohexane?



- (a) I & II (b) II & III (c) I & III (d) Only II

Fill in the blanks with the correct word

- (xi) Symmetry elements presents in the boat form of cyclohexane _____.
- (xii) A strong field ligand generally produces a _____ spin complex.
- (xiii) Heat evolved in chemisorption is very_____.
- (xiv) The molecular aggregates that are formed above the CMC are known as _____.
- (xv) The temperature at which the most probable speed of SO_2 will be the same as that of O_2 at 27°C is _____ $^\circ\text{C}$.

Group - B

2. (a) Write without derivation the Maxwell 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, $\bar{u}_x$, considering the average value to total kinetic energy as $3/2KT$, State the principle of equipartition of energy. [[CO1](Apply)/(IOCQ)]
- (b) Discuss the origin of charge on colloidal particle. [[CO2/Remember/(LOCQ)]
- (c) Calculate the value of delocalization energy of butadiene (without derivation) using the value of HMOs energies. [[CO2](Apply)/(IOCQ)]
- 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](Remember)/(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](Apply)/(IOCQ)]
- (c) Using the Hückle molecular orbital method carry out the calculation of π -MO's of ethylene molecule. [[CO2](Remember)/(LOCQ)]
- 3 + (3 + 3) + 3 = 12**

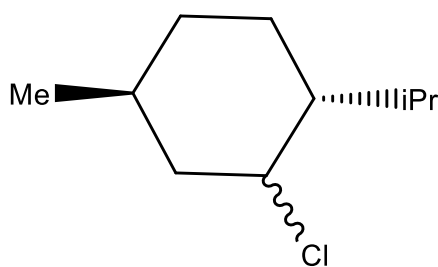
Group - C

4. (a) Write using IUPAC rules, the names of the following complex compounds:
 $\text{K}[\text{Co}(\text{CO})_4]$, $[\text{Co Br}(\text{NCS})(\text{en})_2]\text{Cl}$ [[CO3](Remember)/(LOCQ)]

- (b) Draw a labelled diagram to show splitting of degenerate d-orbitals in the tetrahedral crystal field for the ion $[\text{FeCl}_4]^{2-}$ and calculate the CFSE of the complex ion. [[C03](Remember)/(LOCQ)]
- (c) $[\text{CoF}_6]^{3-}$ is paramagnetic while $[\text{Co}(\text{CN})_6]^{3-}$ is diamagnetic –explain on the basis of CFT. [[C03](Remember)/(LOCQ)]
- (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. [[C03](Remember)/(LOCQ)]
 $2 + 3 + 4 + 3 = 12$
5. (a) Sketch the possible geometrical isomers of $[\text{PtCl}_2(\text{NH}_3)_2]$. Why tetrahedral complexes are unable to exhibit geometrical isomerism. [[C03](Remember)/(LOCQ)]
- (b) The value of observed magnetic moment of $[\text{Ni}(\text{H}_2\text{O})_6]\text{Cl}_2 = 2.9 \text{ BM}$ —Explain using crystal field theory. [[C01](Apply)/(IOCQ)]
- (c) The Δ_o value of $[\text{Mn}(\text{H}_2\text{O})_6]^{3+}$ is found to be $21,000 \text{ cm}^{-1}$. The pairing energy of Mn(III) is $28,000 \text{ cm}^{-1}$. Predict with reason whether the given complex ion is high spin or low spin. [[C01](Apply)/(IOCQ)]
- (d) Explain using diagram the ‘Synergic effect’ in the formation of terminal metal–carbonyl bond. [[C03](Remember)/(LOCQ)]
 $(2 + 2) + 3 + 2 + 3 = 12$

Group - D

6. (a) Two diastereomers of the following compound differ in the orientation of Cl. One isomer undergoes E2 dehydrohalogenation 200 times faster than the other. Draw the conformations of the two diastereomers and identify the most reactive isomer for the said reaction. Explain the observation. Predict the products of the above said reactions with mechanism.



[[C05](Apply)/(IOCQ)]

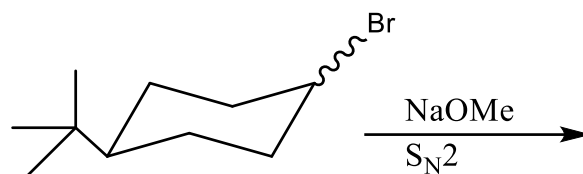
- (b) Draw the chair conformations of 1-methylcyclohexane in Newman projection formula. Referring this representation explain why the methyl group prefers to stay equatorially rather than axial position. Identify the non-bonded interactions existing in the axially substituted 1-methylcyclohexane. [[C05](Remember)/(LOCQ)]
- (c) Evaluate the optical properties of Trans 1, 2 dimethylcyclohexane. [[C05](Remember)/(LOCQ)]

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

7. (a) Draw all the possible chair conformations of 1-methyl cyclohexane. Identify the most stable conformation. Justify your answer mentioning 1-3 di axial interactions in the substituted cyclohexane. [[C05](Remember)/(LOCQ)]
- (b) Draw the structure of 12-crown-4. Explain why only PhCH_2Br is added to a suspension of LiF in Benzene, no reaction occurs. Discuss mechanistically in what condition PhCH_2F can be isolated in high yield? [[C01](Remember)/(LOCQ)]

- (c) When trans-2-methyl cyclohexanol is treated with p-toluene sulphonyl chloride following by KOEt, 3-methyl cyclohexene is the only product, on the other hand cis-2-methyl cyclohexanol under the same condition, gives 1-methyl cyclohexene as the main product. Account the differences. [[CO5)(Apply)/(IOCQ]]

(d)



Considering the above reaction explain why compare to equatorial bromide, axial bromide react much faster rate in S_N2 displacement though transition state (TS) involved is the same. [[CO5)(Apply)/(IOCQ]]

$$(1 + 0.5 + 1.5) + (1 + 1 + 2) + 2 + 3 = 12$$

Group - E

8. (a) What is the cause of Wilson's disease? Give example of a chelating drug to treat Wilson's disease? [[CO4)(Remember)/(LOCQ]]
- (b) Mention the geometries of central Fe (II) in deoxy and oxy form of haemoglobin. [[CO4)(Remember)/(LOCQ]]
- (c) What is Bakelite? How is it form? What are the applications of Bakelite? [[CO1)(Remember)/(LOCQ]]
- (d) Derive thermodynamically the Gibbs adsorption isotherm. [[CO6)(Apply)/(IOCQ]]
- $$(1 + 1) + 2 + (1 + 2 + 1) + 4 = 12$$
9. (a) In case of oxygen binding to haemoglobin (Hb_4), the value of successive binding constant increases ($K_1 < K_2 < K_3 < K_4$)-Explain. [[CO4)(Remember)/(LOCQ]]
- (b) What is Pernicious anaemia? What is the cause of this disease? [[CO4)(Remember)/(LOCQ]]
- (c) 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)(Apply)/(IOCQ]]
- (d) Write the properties and applications of synthetic metal. [[CO1)(Remember)/(LOCQ]]
- $$2 + (1 + 1) + 4 + (2 + 2) = 12$$

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	59.37	40.62	0