

CHEMISTRY – I
(CHM1001)

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) Which of the following behaves as rechargeable battery?
 (a) Zn (s) / ZnSO₄ (aq.) // CuSO₄ (aq.) / Cu (s)
 (b) Pb(s) / H₂SO₄ (aq.) (saturated with PbSO₄) / PbO₂(s)
 (c) PbO₂(s) / H₂SO₄ (aq.) (saturated with PbSO₄) / Pb (s)
 (d) Zn (s) / H₂SO₄ (aq.) / Cu (s)
- (ii) Clausius Clapeyron Equation deals with the
 (a) Change of vapour pressure with temperature
 (b) Effect of an inert gas on vapour pressure
 (c) Calculation of ΔG for spontaneous phase change
 (d) Temperature dependence of heat of phase transition
- (iii) Which is the correct order of electronegativity along a group?
 (a) F < Cl < Br < I
 (b) F < Br < Cl < I
 (c) F > Cl > Br > I
 (d) F > Cl > Br = I
- (iv) Choose the correct stability order
 (a) N₂ > N₂⁺ = N₂⁻ > N₂²⁻
 (b) N₂ > N₂⁺ > N₂⁻ > N₂²⁻
 (c) N₂ < N₂⁺ < N₂⁻ < N₂²⁻
 (d) N₂ < N₂⁺ < N₂⁻ = N₂²⁻
- (v) Which among the followings is not an acceptable solution of Schrodinger's wave equation?
 (a) ψ must be continuous
 (b) ψ must be infinite
 (c) ψ must be single valued
 (d) +∞ to -∞, ψ² must be equal to 1
- (vi) The azimuthal quantum number (l) describes
 (a) Energy and size of the orbit
 (b) Shape of the orbital
 (c) Spatial orientation of the orbital
 (d) Spin of the electron
- (vii) The molecule having highest absorption maxima (λ_{max}) among the following is
 (a) Ethylene (b) Naphthalene (c) Anthracene (d) Benzene

- (viii) An electrophile must possess
 (a) Lone pair of electrons (b) Negative charge
 (c) Positive charge (d) Vacant orbital
- (ix) Anti-Markonikoff's addition of HBr is not observed in
 (a) 1-butene (b) 2-butene
 (c) 1-pentene (d) Propene
- (x) Identify the chiral molecule among the following?
 (a) Ethanol (b) 1-Pentanol
 (c) 2-Pentanol (d) 3-Pentanol

Fill in the blanks with the correct word

- (xi) The Debye force is the interaction between dipole and _____.
- (xii) The hybridization pattern of O in H₂O is _____.
- (xiii) During phosphorescence the transition from singlet state to corresponding triplet state is called _____.
- (xiv) In NMR spectroscopy the difference in the absorption position of proton with respect to _____ is called chemical shift.
- (xv) The major product obtained when 2-bromobutane is treated with ethanolic KOH _____.

Group - B

2. (a) Write two statements of Second Law of Thermodynamics. Starting from the expression of the efficiency of a reversible heat engine, show that its efficiency cannot be 100%. [[CO1](Apply/IOCQ)]
- (b) Derive the expression for entropy change of an ideal gas for variable volume and temperature. [[CO1](Remember/LOCQ)]
- (c) Consider the cell reaction $Zn + 2Ag^+ \rightarrow Zn^{2+} + 2Ag$. Represent the cell configuration & write the half-cell Nernst equations. Find out E°_{cell} (given the respective reduction potentials as, $E^{\circ}_{Zn^{2+}/Zn} = -0.76 V$ & $E^{\circ}_{Ag^+/Ag} = +0.80 V$) [[CO2](Apply/IOCQ)]
- (d) Write the configuration of Leclanche cell and express the electrode reactions. [[CO2](Remember/LOCQ)]
(2 + 2) + 2 + 3 + 3 = 12
3. (a) For the change of state (liquid \rightleftharpoons vapour) arrive at the Clausius-Clapeyron equation. [[CO1](Remember/LOCQ)]
- (b) Calculate the entropy change for the expansion of 5 moles of ideal gas isothermally and reversibly from 10litre to 100litre at 300 K. [[CO1](Apply/IOCQ)]
- (c) Describe the Calomel Electrode with configuration and write down the Nernst equation for the electrode reaction. [[CO2](Remember/LOCQ)]
- (d) How does localized electrochemical cell formation aggravate rusting of iron? Illustrate with half-cell oxidation and reduction reactions. [[CO2](Apply/IOCQ)]
4 + 3 + 2 + 3 = 12

Group - C

4. (a) Draw the structure of XeF_2 molecule and mention the hybridization of the central atom. Write down the differences between the bonding and antibonding molecular orbitals. [[CO3](Remember/LOCQ)]
- (b) What do you understand by conduction band? Explain how the conductivity of a semiconductor varies with increasing temperature? [[CO3](Remember/LOCQ)]
- (c) Find the screening constant and effective nuclear charge of a d-electron of Mn ($Z=25$) atom. [[CO4](Apply/IOCQ)]
- (d) Which of the following compounds contains most acidic hydrogen C_2H_2 , C_2H_4 , C_2H_6 ? Give reasons. [[CO4](Remember/LOCQ)]
- (2 + 2) + 3 + 2 + 3 = 12**

5. (a) Calculate the bond orders for the species O_2 , O_2^+ , O_2^- (superoxide) and O_2^{2-} (peroxide); compare their relative stabilities and indicate their magnetic properties. [[CO3](Apply/IOCQ)]
- (b) What do you understand by forbidden gap? In terms of forbidden gap differentiate conductor and semiconductor. Give example for each case. [[CO3](Remember/LOCQ)]
- (c) Define ionization potential (IP). Why does the $(\text{IP})_{\text{II}}$ of alkaline earth metal is greater than $(\text{IP})_{\text{I}}$. [[CO4](Remember/LOCQ)]
- (d) On the basis of HSAB principle complete the following reaction with reason, $\text{HgF}_2 + \text{BeI}_2 \rightarrow$. [[CO3](Apply/IOCQ)]
- 4 + 3 + 3 + 2 = 12**

Group - D

6. (a) Write down the possible values of four quantum numbers for the valence electrons of calcium (Ca-20). [[CO3](Remember/LOCQ)]
- (b) Write down the Schrodinger's wave equation mentioning the terms involved in the equation. [[CO3](Remember/LOCQ)]
- (c) The fundamental frequency of vibration of CO molecule is 2140 cm^{-1} . Calculate the force constant of the bond. (Given: atomic mass of C is $1.99 \times 10^{-6} \text{ kg}$ and of O is $2.66 \times 10^{-6} \text{ kg}$) [[CO5](Remember/LOCQ)]
- (d) Relate the λ_{max} values (i) 277 ($\epsilon \sim 100$) and 185nm ($\epsilon \sim 2000$) and (ii) 324 ($\epsilon \sim 24$) and 219nm ($\epsilon \sim 3660$) to the compounds $\text{CH}_3\text{COCH}_2\text{CH}_3$ and $\text{CH}_3\text{COCH}=\text{CH}_2$. Identify the electronic transitions in each case. [[CO5](Apply/IOCQ)]
- 4 + 2 + 2 + 4 = 12**
7. (a) Write the wave function and the total energy of particle in a one-dimensional box for $n=2$ state. Indicate the number of nodes in the wave. [[CO3](Remember/LOCQ)]
- (b) State and explain de Broglie's principle for the wave particle duality. [[CO3](Remember/LOCQ)]
- (c) A chemical substance absorbs 3×10^{18} quanta of light per sec. On irradiation for 20 minutes 0.003 mole of the substance was found to have reacted. Calculate the quantum yield of the process. [[CO5](Apply/IOCQ)]

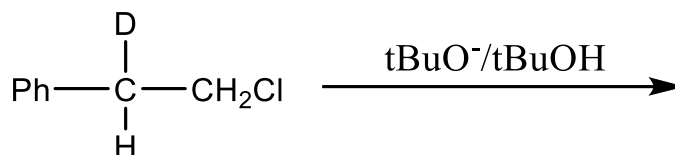
- (d) Out of the following pairs which one is expected to absorb at higher frequency for stretching vibration? (i) C=C, C-C and (ii) O-H, C-C. Justify your answer.

[[CO5](Remember/LOCQ)]

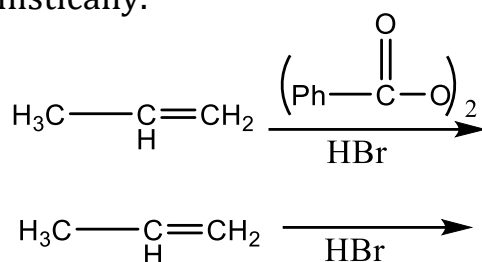
(2 + 2) + 2 + 3 + 3 = 12

Group - E

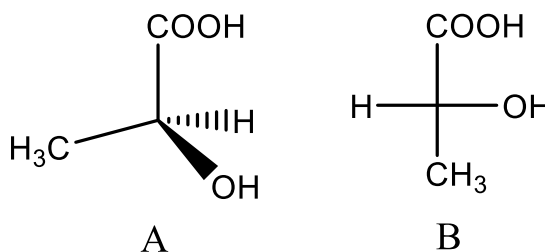
8. (a) Show that meso tartaric acid contains an S_2 axis. [[CO6](Apply/IOCQ)]
 (b) Depict the mechanism of the following reaction. Identify the major product. Justify your answer. [[CO6](Apply/IOCQ)]



- (c) Predict the major product(s) of the following reactions and explain their formation mechanistically. [[CO6](Apply/IOCQ)]



- (d) Find out the absolute configuration of each of the stereo centres of the following molecules A and B. Identify the relation between them. [[CO6](Remember/LOCQ)]



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

9. (a) Depict the synthetic route of Aspirine. Mention its uses and side effects. [[CO6](Remember/LOCQ)]
 (b) Explain for a particular nucleophilic substitution reaction (S_N1) of tert-butyl bromide is found to be 3×10^4 times faster in 50% aqueous ethanol than 100% ethanol. [[CO6](Apply/IOCQ)]
 (c) Differentiate between enantiomer and diastereomers with examples. [[CO6](Remember/LOCQ)]
 (d) Draw the energy profile diagram of the different conformations of n-butane. Identify the most stable and unstable conformation. [[CO6](Remember/LOCQ)]

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

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	59.38	40.62	0