

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) In which of the following cases the reaction is spontaneous at all temperatures?
 (a) $\Delta H > 0, \Delta S > 0$ (b) $\Delta H < 0, \Delta S > 0$
 (c) $\Delta H < 0, \Delta S < 0$ (d) $\Delta H > 0, \Delta S < 0$
- (ii) Identify the name of the electrode when silver foil is dipped in a solution containing KCl and a pinch of silver nitrate solution added to it.
 (a) Ag / Ag⁺ (aq.) electrode (b) Ag / Cl⁻ (aq.) electrode
 (c) Ag-AgCl / Cl⁻ (aq.) electrode (d) Ag / NO₃⁻ (aq.) electrode
- (iii) The polarizing power of the ions increases in the order
 (a) Na⁺ < Mg²⁺ < Al³⁺ (b) Mg²⁺ < Na⁺ < Al³⁺
 (c) Mg²⁺ < Al³⁺ < Na⁺ (d) Al³⁺ < Mg²⁺ < Na⁺
- (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) For CH₄ the number of vibrational mode is
 (a) 9 (b) 8 (c) 10 (d) 15
- (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 order of elimination of halogens in 1°, 2° and 3° alkyl halide is
 (a) 2° > 3° > 1° (b) 3° > 2° > 1°
 (c) 3° > 1° > 2° (d) 1° > 2° > 3°
- (viii) (CH₃)₃CCl + (CH₃)₃CO·K⁺ →
 (a) S_N product will be more (b) E₂ product will be more
 (c) Both will be the same (d) None of these

- (ix) With respect to the conformers of ethane, which of the following statements is true?
 (a) Bond angle remains same but bond length changes
 (b) Bond angle changes but bond length remains same
 (c) Bond angle and bond length change
 (d) Both bond angle and bond length remains same
- (x) 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

Fill in the blanks with the correct word

- (xi) In a Carnot Engine operating between two temperatures T_1 (source) and T_2 (sink), if $T_1 > T_2$, efficiency of the Engine is _____ than one.
- (xii) The hybridization pattern of O in H_2O is _____.
- (xiii) During phosphorescence the transition from singlet state to corresponding triplet state is called _____.
- (xiv) The number of stereoisomers are possible for the compound of the formula $CHOCHOHCHOHCH_2OH$ _____.
- (xv) S_N1 reaction on optically active substrates mainly gives _____ product.

Group - B

2. (a) Show that Joule-Thompson effect is iso-enthalpic. [[CO1](Remember/LOCQ)]
 (b) 3 moles of an ideal gas with $C_v = 5.0 \text{ Cal K}^{-1} \text{ mole}^{-1}$ is expanded adiabatically and reversibly from a volume of 10 litre to 20 litre at 300K. Calculate the final temperature of the gas. (Given $R = 2 \text{ Cal K}^{-1} \text{ mole}^{-1}$). [[CO1](Apply/IOCQ)]
 (c) Zn corrodes when exposed to HCl. What are the localized cell reactions aggravating corrosion? [[CO2](Remember/LOCQ)]
 (d) Specify the Electrode & Electrolyte Components of Lead-acid Storage Cell and express the overall charging-discharging reactions. [[CO2](Remember/LOCQ)]
2 + 3 + 3 + 4 = 12
3. (a) Gibbs free energy is given by $G = H - TS$. Considering this equation, derive Gibbs-Helmoltz equation in terms of ΔG and its temperature coefficient. Define Helmholtz free energy. [[CO1](Remember/LOCQ)]
 (b) Represent the cell configuration for the half-cell reactions
 $Cd^{+2} + 2e = Cd$; $E^0 = -0.402 \text{ V}$
 $Hg_2Cl_2 + 2e = 2Hg + 2Cl^-$; $E^0 = +0.268 \text{ V}$
 Calculate E^0 of the cell at 25°C and evaluate ΔG^0 and equilibrium constant of the cell reaction. [[CO2](Apply/IOCQ)]
 (c) Write the configuration of Leclanche cell and express the electrode reactions. [[CO2](Remember/LOCQ)]

- (d) Calculate the change in entropy when pressure of two mole of ideal gas is isothermally reduced from 5.0 atm to 0.5 atm.

[[C01](Apply/IOCQ)]

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

Group - C

4. (a) State SHAB principle. Explain with SHAB principle that why the addition of fluoride ion in BF_3 gives a stable complex? [[C04](Remember/LOCQ)]
- (b) Discuss the hybridization and draw the structures of BeF_2 and BrF_3 molecule. [[C03](Apply/IOCQ)]
- (c) Find the screening constant and effective nuclear charge of a d-electron of Mn (Z=25) atom. [[C04](Apply/IOCQ)]
- (d) Which of the following compounds contains most acidic hydrogen C_2H_2 , C_2H_4 , C_2H_6 ? Give reasons. [[C04](Remember/LOCQ)]
- 3 + 4 + 2 + 3 = 12**
5. (a) In period periodic table the Cu has higher ionization energy than K though both have the same valence shell configuration – Explain. [[C04](Remember/LOCQ)]
- (b) What do you understand by forbidden gap? In terms of forbidden gap differentiate conductor and semiconductor. Give example for each case. [[C03](Remember/LOCQ)]
- (c) Draw the energy level diagram of F_2 molecule. What is the order of stability among F_2^{2+} , F_2 and F_2^- ? [[C03](Apply/IOCQ)]
- (d) On the basis of HSAB principle complete the following reaction with reason, $\text{HgF}_2 + \text{BeI}_2 \rightarrow$. [[C03](Apply/IOCQ)]
- 3 + 3 + 4 + 2 = 12**

Group - D

6. (a) Calculate the wavelength of emitted light for the electronic transition from $n=4$ to $n=1$ energy level for the hydrogen atom. In which region of electromagnetic spectrum does this radiation fall? ($R_H=1.096776 \times 10^7 \text{m}^{-1}$). [[C03](Apply/IOCQ)]
- (b) UV spectrum of the α , β unsaturated ketone, $\text{Me}_2\text{C}=\text{CH}-\text{COMe}$, shows absorption band at 230nm and 321nm in isooctane (nonpolar solvent). Assign them in terms of electronic transition. How the absorption bands do changes their positions with the change of solvent from isooctane to water (polar solvent)? Give reasons with your answer. [[C05](Understand/LOCQ)]
- (c) What do you know about the nodal plane in an atomic orbital? Draw the shape of d_{xy} , d_{yz} and d_{xz} orbital mentioning their nodal planes. [[C03](Apply/IOCQ)]
- 4 + 4 + 4 = 12**
7. (a) Explain with proper justification when p-nitrophenol is dissolved in water the colour is yellow, but when NaOH is added, the colour depends on intensity and moves to longer wavelength in UV-absorption. Identify the nature of spectral shift. [[C05](Apply/IOCQ)]
- (b) A chemical substance absorbs 3×10^{18} quanta of light per sec. On irradiation for 20minutes 0.003 mole of the substance was found to have reacted. Calculate the

quantum yield of the process.

[[CO5](Apply/IOCQ)]

- (c) Which of the isomers of pentadiene, (a) $\text{CH}_2=\text{CHCH}=\text{CHCH}_3$ and (b) $\text{CH}_2=\text{CHCH}_2\text{CH}=\text{CH}_2$ will show the longest wavelength of UV absorption? Justify your answer.

[[CO5](Apply/IOCQ)]

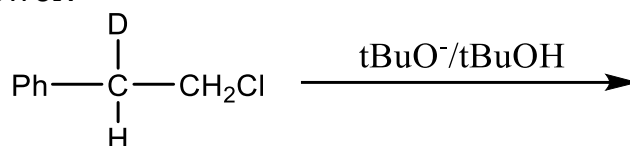
- (d) Differentiate between hypochromic and hyperchromic shift involve in UV-Vis spectra providing suitable example.

[[CO5](Apply/IOCQ)]

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

Group - E

8. (a) Depict the mechanism of the following reaction. Identify the major product. Justify your answer.



[[CO6](Apply/IOCQ)]

- (b) Define plane of symmetry with suitable example. Identify rotational axis of proper fold and the total number of σ planes present in Formaldehyde molecules.

[[CO6](Remember/LOCQ)]

- (c) Differentiate between enantiomer and diastereomers with examples.

[[CO6](Remember/LOCQ)]

- (d) Halogens are ortho-para orienting towards electrophilic substitution and deactivating the benzene ring cloud. Give reasons.

[[CO6](Remember/LOCQ)]

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

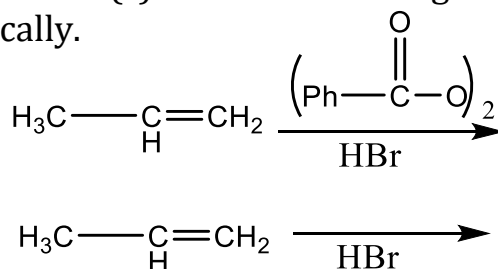
9. (a) Depict the detail synthetic route, uses and side effects of Paracetamol.

[[CO6](Remember/LOCQ)]

- (b) Draw all Fischer projection formula of the following stereoisomers. (i) (2R, 3R)-2,3-dibromobutanedioic acid, (ii) S-2-hydroxy-2-phenyl propanoic acid.

[[CO6](Apply/IOCQ)]

- (c) Predict the major product(s) of the following reactions and explain their formation mechanistically.



[[CO6](Apply/IOCQ)]

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

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	46.88	53.12	0