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) Joule Thomson expansion of an ideal gas is
(a) Isochoric process (b) Isobaric process
(c) Isoenthalpic process (d) Isothermal process

(ii) Iron spontaneously undergoes corrosion to form Rust. Identify the molecular formula of rust.
(a) FeO, $2H_2O$ (b) Fe_2O_3, xH_2O
(c) Fe_3O_4, $2H_2O$ (d) Fe_3O_4, xH_2O

(iii) Which of the following is the correct electronic configuration of He_2^+?
(a) $\sigma_{1s}^1\sigma^*_{1s}^1$ (b) $\sigma_{1s}^2\sigma^*_{1s}^1$
(c) $\sigma_{1s}^2\sigma^*_{1s}^2$ (d) $\sigma_{1s}^1\sigma^*_{1s}^2$.

(iv) The hybridization pattern of PCl_5 molecule
(a) sp^3 (b) sp^3d
(c) sp^2 (d) sp^3d^2

(v) Which of the following species is diamagnetic?
(a) H_2^+ (b) H_2^-
(c) O_2 (d) N_2.

(vi) Which of the following electromagnetic radiations is capable of making electronic transition in atoms or molecules?
(a) Radio wave (b) Infrared
(c) Ultraviolet (d) None of these.

(vii) For CH_4 the number of vibrational mode is
(a) 9 (b) 8
(c) 10 (d) 15

(viii) The most appropriate statement regarding fluorescence and phosphorescence is
(a) Singlet-singlet and triplet-singlet transition
(b) Singlet-singlet and triplet-triplet transition
(c) Triplet-singlet and singlet-singlet transition
(d) Singlet-triplet and triplet-singlet transition.

(ix) Which of the following isomerism is shown by only alkenes but not by alkanes?
(a) Conformational (b) Geometrical
(c) Optical (d) Chain.

(x) 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.

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) When Pt wire is dipped in an acidic solution of $FeSO_4$ (redox couple $Fe^{+2/+3}$), the electrode formed is classified as _____ electrode.

(xiii) The first ionisation potential of Be is _____ than that of B.

(xiv) The value of azimuthal quantum number corresponds to f orbital is _____.

(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) 10 moles of an ideal gas initially at 1atm pressure and 0°C is expanded reversibly and isothermally to a final pressure of 0.1atm. Calculate the work done by the gas, internal energy change and heat absorbed by the system. (Given: R =8.314J $K^{-1}mol^{-1}$). *[(CO1)(Apply/IOCQ)]*

(c) Represent the cell configuration for the half-cell reactions
$Cd^{+2} + 2e = Cd$; $E^0 = -0.402$ V
$Hg_2Cl_2 + 2e = 2Hg + 2Cl^-$; $E^0 = +0.268$ V
Calculate E^0 of the cell at 25 ^{0}C and evaluate ΔG^0 and equilibrium constant of the cell reaction. *[(CO2)(Apply/IOCQ)]*

(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 Helmoltz free energy. *[(CO1)(Remember/LOCQ)]*

(b) Starting from the expression for efficiency of a Carnot Engine arrive at the definition of entropy function. *[(CO1)(Remember/LOCQ)]*

(c) If Zn and Cu rods are dipped in dilute H_2SO_4 and connected through conducting wires in the outer circuit what will be the electrode reactions? *[(CO2)(Apply/IOCQ)]*

(d) Express the electrode reactions in a H_2-O_2 Fuel Cell. What is the function of Polymer Electrolyte Membrane, in such cell operating in acid medium? *[(CO2)(Remember/LOCQ)]*

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

Group - C

4. (a) Draw the structure of PCl_3F_2 molecule and indicate the axial and the equatorial bonds. Also mention the hybridization of the central atom. *[(CO3)(Remember/LOCQ)]*

(b) Draw the energy level diagram of B_2 molecule, calculate bond order and account for its magnetic behaviour. *[(CO3)(Apply/IOCQ)]*

(c) The first ionization potential of Au is more (890KJ mol^{-1}) than that of Ag (731KJ mol^{-1}) which is contrary to the general periodic trend- Explain. *[(CO4)(Apply/IOCQ)]*

(d) State SHAB principle. Explain with SHAB principle that why the addition of fluoride ion in BF_3 gives a stable complex? *[(CO4)(Remember/LOCQ)]*

3 + 3 + 3 + 3 = 12

5. (a) What are the conditions for the formation of molecular orbitals (MOs) by the combination of atomic orbitals (AOs)? Sketch the shapes of molecular orbitals formed by the "End On" overlap of two p-orbitals and name the MOs formed. *[(CO3)(Remember/LOCQ)]*

(b) Using Slater's rule, calculate the shielding constant and therefore find out the effective nuclear charge experienced by the first valence electron in Ca (Z=20). *[(CO4)(Apply/IOCQ)]*

(c) The first ionization energy of elements increases from left to right in a given period of the periodic table but Zn (IE =906KJ mol^{-1}) has higher ionization energy than Ga (IE = 578KJ mol^{-1}) –Explain. *[(CO4)(Apply/IOCQ)]*

(d) $[AgI_2]^-$ is more stable than $[AgF_2]^-$– Explain on the basis of SHAB principle. *[(CO4)(Apply/IOCQ)]*

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

Group - D

6. (a) What is the importance of de Broglie's relation? Consider a beam of electron with a speed of 5.31×10^6 m/s, calculate the de Broglie wavelength (Mass of electron = 9.11×10^{-31}kg; h=6.626×10^{-34}Js). *[(CO3)(Apply/IOCQ)]*

(b) State and explain Pauli's exclusion principle. In which region of the electromagnetic spectrum of hydrogen atom does the Lyman series exist? *[(CO3)(Remember/LOCQ)]*

(c) Differentiate between hypochromic and hyperchromic shift involve in UV-Vis spectra providing suitable example. *[(CO5)(Apply/IOCQ)]*

(d) Explain the terms internal conversion and inter system crossing by drawing a labelled Jablonski diagram. *[(CO5)(Remember/LOCQ)]*

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

7. (a) Which of the isomers of pentadiene, (i) $CH_2=CHCH=CHCH_3$ and (ii) $CH_2=CHCH_2CH=CH_2$ will show the longest wavelength of UV absorption? Justify your answer. *[(CO5)(Apply/IOCQ)]*

(b) How many vibrational modes are possible for a linear and non linear molecule having 'n' atoms? Draw the symmetric and asymmetric stretching modes of vibration of carbon dioxide molecule. *[(CO5)(Remember/LOCQ)]*

(c) What is ψ? What information is conveyed by ψ and ψ^2? *[(CO3)(Remember/LOCQ)]*

(d) Kinetic energy of a subatomic particle is 5.85×10^{-25} J. Calculate the frequency of the particle wave. (Given Plank's constant, h= 6.6×10^{-34}kg m^2s^{-1}). *[(CO3)(Apply/IOCQ)]*

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

Group - E

8. (a) Explain with reason why alkyl halides react with ethanolic KCN to form alkyl cyanides while they react with ethanolic AgCN to give alkyl isocyanides as the major products. *[(CO6)(Apply/IOCQ)]*

(b) Outline the reaction with main product when acetone is treated with perbenzoic acid. *[(CO6)(Remember/LOCQ)]*

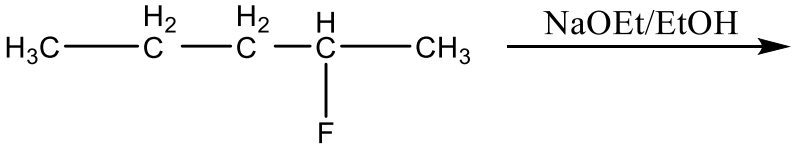
(c) Discuss chain isomers with example. How it differs from position isomerism? Draw the geometrical isomers of 1, 2-dimethyl cyclohexane. *[(CO6)(Remember/LOCQ)]*

(d) Depict the detail synthetic route, uses and side effects of Paracetamol. *[(CO6)(Remember/LOCQ)]*

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

9. (a) Arrange the following molecules in the order of increasing reactivity in substitution reaction: CH_3Br, CH_3I and CH_3Cl. *[(CO6)(Remember/LOCQ)]*

(b) Write the products obtained in the following reaction. Predict the major product. Justify your answer.



[(CO6)(Apply/IOCQ)]

(c) Meso tartaric acid is optically inactive. Justify your answer. Write short note on centre of symmetry. *[(CO6)(Remember/LOCQ)]*

(d) Draw the fully eclipsed and anti-staggered form of n-butane molecule in Sawhorse and Newman projection formula. *[(CO6)(Apply/IOCQ)]*

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

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	58.33	41.67	0