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1 (Sem-2/FYUGP) CHE 21MJ

2026

CHEMISTRY

(Major)



Paper : CHE4200104MJ

(Chemistry-II)

Full Marks : 45

Time : 2 hours

*The figures in the margin indicate
full marks for the questions.*

1. Answer the following questions : $1 \times 5 = 5$

- (a) What are hybrid orbitals ?
 (b) Primary and secondary valencies in $[Pt(NH_3)_4]Cl_4$ respectively are— (choose the correct answer)

(i) 4 and 6

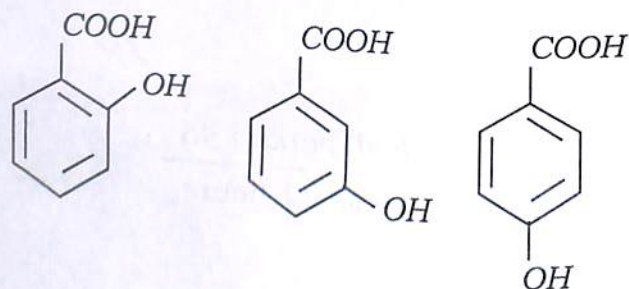
(ii) 6 and 4

(iii) 3 and 4

(iv) 4 and 3

- (c) What are nitrenes ?

- (d) Arrange the following in increasing order of acid strengths—



- (e) Define a reversible process.

2. Answer (**any five**) of the following questions : $2 \times 5 = 10$

- (a) What are equivalent and non-equivalent hybrid orbitals ?

- (b) Draw the possible resonance structures of phenoxide ion.

- (c) Draw the MO diagram of CO molecule.

- (d) How coordination complexes are different from double salts ?

- (e) Both $[Ni(CO)_4]$ and $[NiCl_4]^{2-}$ are tetrahedral. But $[Ni(CO)_4]$ is diamagnetic whereas $[NiCl_4]^{2-}$ is paramagnetic. Explain.

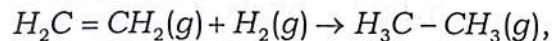
- (f) Explain how nitro group at *ortho*, *meta* and *para* positions of benzyl carbanion influence its stability.

- (g) With the help of a suitable example explain the mechanism involving a pentavalent transition state.

- (h) Define dissociation constant K_a for a weak acid.

pK_a values of CH_3COOH and $ClCH_2COOH$ are 4.7 and 2.8 respectively. Explain.

- (i) Define heat and work.
- (j) Calculate C=C bond enthalpy from the following reaction—



$$\Delta H = -125.5 \text{ kJ}$$

Bond enthalpies of C - C, C - H and H - H are 347.3, 414.2 and 435.1 kJ mol⁻¹ respectively.

- (k) Give the criterion of spontaneity of a process in terms of Gibbs free energy change. Give its limitations.

3. Answer **any four** of the following questions :
5×4=20

- (a) (i) Explain the necessity of hybridization of atomic orbitals. Give the conditions of hybridization of atomic orbitals. 1+2=3

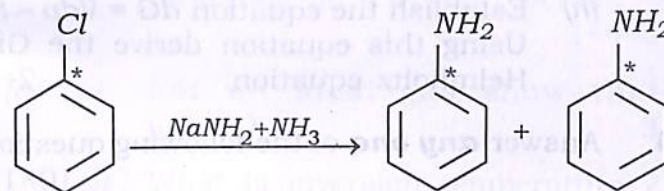
- (ii) Write the MO electronic configuration of HCl molecule. Draw the energy level diagram of the HCl molecule. 1+1=2

- (b) Explain the Fajan's rule for polarizability of a bond. Explain the factors with suitable examples that enhances the covalent nature of a bond.

$$2+3=5$$

- (c) With the help of suitable example explain Berry pseudorotation.

- (d) Chlorobenzene labelled with ¹⁴C(*) at the position to which the chlorine is attached was treated with sodium amide in liquid ammonia. The aniline produced was analysed to determine the position of the ¹⁴C label. The results are indicated below. Show how these data is consistent with the benzyne intermediate.



- (e) Give an example of rearrangement reaction. Explain the mechanism of the reaction. 1+4=5

- (f) (i) Discuss the protonic and electronic theories of acid and bases. Give examples. Which of the *two* theories is more generalised ? 3+1=4

- (ii) Write the conjugate acid and conjugate base of NH₃ molecule.

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- (g) (i) What is a thermochemical equation?

For combustion of methane gas $890.36 \text{ kJ mol}^{-1}$ heat is evolved. Write the thermochemical equation for the reaction. $1+1=2$

- (ii) Calculate q , w , ΔU in SI units when 2 moles of an ideal gas isothermally and reversibly compressed from 1 atm to 2 atm at 27°C . 3

- (h) Establish the equation $dG = Vdp - SdT$. Using this equation derive the Gibbs Helmholtz equation. $2+3=5$

4. Answer **any one** of the following questions : $10 \times 1 = 10$

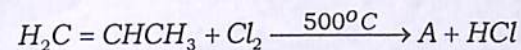
- (a) (i) Applying the VSEPR theory, discuss about the geometries of AB_4 , AB_4L and AB_3L_2 types of molecules, where L represents lone pair of electrons. Give suitable example of each type of molecules. 6

- (ii) Give the drawbacks of the VSEPR theory. 4

- (b) With the help of suitable example discuss about the different types of weak chemical forces that may exist between molecules.

- (c) (i) What are the free radicals? How free radicals are generated in chemical reaction. Mention the conditions favouring the formation of free radicals. $1+2+2=5$

- (ii) Identify the product A in the following reaction—



Explain the mechanism of formation of A in the reaction. $1+4=5$

- (d) (i) For an ideal gas show that $\mu_{JT} = 0$. 3

- (ii) What is inversion temperature? Derive an expression for Joule-Thomson coefficient of a real gas and show that $T_i = \frac{2a}{Rb}$. Symbols signify the usual meanings. $1+4+2=7$