Registration No.: | | | | | | | | | | |

Total Number of Pages: 03

Course: B.Tech/IDD
Sub_Code: 23BS1003

1st Semester Regular/Back Examination: 2024-25
SUBJECT: Chemistry
BRANCH(S): CHEM, CIVIL, BIOTECH, BIOMED, AE, CSIT, AEIE, AERO, AUTO, AME, CSE, CSEAI, CSEAIML, CSEDS, CST, ECE, ECE, ETC, ELECTRONICS & C.E, EEE, EE, ELECTRICAL, ELECTRICAL & C.E, IT, MECH, METTA, MINERAL, MME, MINING, CSEIOT, EEVDT
Time: 3 Hours
Max Marks: 100
Q.Code: R467
Answer Question No.1 (Part-I) which is compulsory, any eight from Part-II and any two from Part-III.
The figures in the right hand margin indicate marks.

Part-I

Q1 **Answer the following questions:** **(2 x 10)**

a) If the inter-nuclear distance between two chlorine atoms in a Cl_2 molecule is 198 pm, what is the covalent radius of chlorine?

b) Write the trend in the percentage of ionic character for HF, HBr, HCl, and HI? Justify your answer.

c) Calculate the entropy change when 1 mole of an ideal gas is heated from 20 °C to 40 °C at a constant pressure. The molar heat at constant gas pressure over this temperature range is 6.189 cal deg^{-1}.

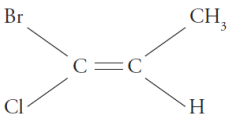
d) If dE = TdS–PdV, prove that

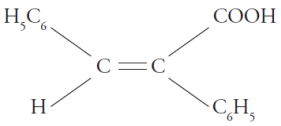
$$\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V$$

e) Arrange the following in increasing order of energy and wavelength:
X-ray, Visible, Gamma ray, Infrared, Microwave, Radiowave, Ultraviolet

f) What is the main criterion for a molecule to Microwave active? Which of the following molecules will show a microwave rotational spectrum:
HCl, CH_4, CH_2Cl_2, CO_2,

g) Assign E & Z to the following compounds





h) Find the number of enantiomers and meso form in the compound: Tartaric acid [CH(OH)COOH • CH(OH)COOH]

i) Define staggered and eclipsed conformation with example.

j) How does s-character affect the stability of carbanions?

Part-II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 x 8)**

a) State Fajan's rule. How do the charge and size of the cation affect polarization and covalent character? What are the limitations of Fajan's rules in predicting covalent character?

b) What is the inert pair effect? Discuss the factors contributing to this effect taking the example of elements of Boron family.

c) (I) Derive Claypeyron–Clausius Equation.
(II) The latent heat of vaporisation of benzene at its boiling point (80 °C) is 7413 cal mol^{-1}. What is the vapor pressure of benzene at 27 °C.

d) (I) Derive the expression for the free energy change of an ideal gas as a function of pressure.
(II) ΔG for a reaction at 300 K is –16 kcal; ΔH for the reaction is –10 kcal. What is the entropy of the reaction? What will be ΔG at 330 K?

e) State Beer's Law. Derive the expression for absorbance of a homogeneous absorbing solution.

f) Discuss the basic principle of UV-Visible spectroscopy giving a detailed description of different types of transition.

g) A 2.0 x 10^{-3} M solution of a compound transmits 20% of the incident radiation of wavelength 400 nm in a cuvette of 1 cm width. Calculate the absorbance and the molar extinction coefficient.

h) Define and give examples of linear, symmetric tops, spherical tops, and asymmetric tops. Mention whether molecules will be microwave-active or not.

i) Define conformational isomerism with an example. Discuss the conformational isomerism of Cyclohexane with the stability.

j) Describe electrophilic addition reactions, including Markovnikov's rule and anti-Markovnikov additions.

k) Discuss the stereochemistry involved in nucleophilic substitution reactions (SN_1 & SN_2).

l) Describe the Friedel-Crafts alkylation mechanism in aromatic compounds.

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 **a)** Define electronegativity by taking a suitable example. How does the electronegativity of elements change across a period and down the group? **(4+8+4)**

b) Discuss the different scales to express the electronegativity of an element.

c) Name the applications of electronegativity and describe any two applications in detail.

Q4 **a)** Define the concept of Entropy and its physical significance. **(4+4+8)**

b) Prove thermodynamically that in an isothermal spontaneous expansion process, the entropy is always increasing.

c) Derive an expression for the entropy change during the mixing of ideal gases. 2 moles of H_2 and 7 moles of N_2 are mixed at 298 K and 1 atmosphere. Assuming the ideal Behavior of the gas, calculate the entropy of mixing per mole of the mixture formed.

Q5 **a)** Write the basic principle of IR spectroscopy and write the expression for vibrational frequency. Mention the factors affecting the vibrational frequency. Also, describe the different types of vibration. **(8+8)**

b) Write the principle of Microwave spectroscopy. Derive the expression for the radius of a diatomic molecule using the application of microwave spectroscopy. Calculate the reduced mass and moment of inertia of $^{1}H^{35}Cl$ if the bond length is 1.27 Å.

Q6 **a)** Define a free radical with examples. How are free radicals generated in organic reactions (2 methods)? **(4)**

b) Discuss the geometry of free radicals and their structural characteristics. **(4)**

c) Arrange the following as per the decreasing stability and explain the trend using factors including ease of formation, hyperconjugation, and resonance. **(8)**

(i) $CH_2 = CH–C•H_2$, $C_6H_5C • H_2$, $(C_6H_5)_3 C•$, $(C_6H_5)_2C•H$

(ii) $C • H_3$, $(CH_3)_2 C• H$, $(CH_3)_3 C•$, $CH_3 C • H_2$