2nd Semester Regular Examination: 2023-24
SUBJECT: Chemistry
BRANCH(S):
AEIE,AUTO,CE,CHEM,CIVIL,CSE,CSEAI,CSEAIME,CSEDS,CST,ECE,EEE,ELECTRICAL,ETC
,MANUTECH,MECH,METTA,MINING,MME,PLASTIC,PT,CE,CSE,ME
Time: 3 Hour
Max Marks: 100
Q.Code: P289
Answer Question No.1 (Part-1) 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 × 10)

a) What is penetration power? Compare the penetration power of different orbital with probability density plot.

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

c) Calculate the entropy change when 5 moles of an ideal gas undergo isothermal expansion at 20 °C from a pressure of 10 atm to a pressure of 2 atm.

d) Define entropy. Write its physical significance.

e) At definite wavelength, absorbers when placed in a cell of 1 cm pathlength absorb 20% of the incident light. If the absorptivity if the absorber at this wavelength is 2. Find out its concentration.

f) What is the main criterion for a molecule to Microwave active? Which of the following molecules will show a microwave rotational spectrum?
   CH_3Cl and CO_2.

g) What is racemic mixture? Mention about its optical activity.

h) Which conformer of cyclohexane (chair/boat) is more stable and why?

i) Justify the stability order Triphenylmethyl > Benzyl > Allyl

j) Write the addition product of $CH_3CH=CH_2$ with HBr in presence and absence of an organic peroxide. Justify your answer.

Part-II

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

a) What is electronegativity? Discuss the different scale to express the electronegativity of element.

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

c) Discuss the basic principles of UV-Visible spectroscopy with a description of different types of electronic transition.

d) Discuss the factors influencing the rate of nucleophilic substitution reactions.

e) I. What happens to the entropy when two ideal gases are mixed with each other? Derive the expression for entropy of mixing.

II. 1 mole of H_2 and 9 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.

f) Derive Claypeyron–Clausius Equation? How does it help in solid-gas explaining the liquid – vapor equilibrium?

g) Define chromophore and auxochrome? Give examples. Discuss the different effects pertaining to the shift of intensity and wavelength due to auxochrome.

h) Write the basic principle of IR spectroscopy and write the expression for vibrational frequency. Discuss about the different types of vibrations.

i) Define and discuss geometrical isomerism with example. Write the conditions required for showing this type of isomerism. Assign E and Z nomenclature to the following compounds.
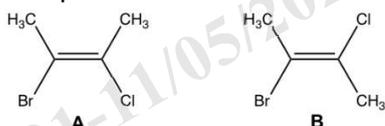
j) Discuss the different optical isomers of tartaric acid giving a brief discussion on the different terms like enantiomers, diastereomers, meso, and racemic isomers.

k) Define free radicals. Give examples. Discuss the structure, any two methods of generation and stability of free radicals.

l) Why aromatic hydrocarbons resistant to addition reactions but can are undergoing substitution reactions? Discuss the Friedel craft's reactions with mechanism.

Part-III

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

Q3 What is meant by periodicity in properties of element? Name the properties showing periodicity in the periodic table. Define the ionization energy and successive ionization energy. Discuss the different factors affecting the ionization energy. Also discuss the trends in ionization energy across the period and group. **(16)**

Q4 a) Write the principle of Microwave spectroscopy. Derive the expression for radius of a diatomic molecule using the application of microwave spectroscopy. **(8x2)**

b) Write the expression for the energy corresponds rotational lines and also find the energy of transition across the different rotational levels. The separation of lines in the microwave spectrum of CO molecules was found to be 298 m^{-1}. Calculate the rotational constant, bond length of the molecule and the energy corresponding to first excited state energy level.

Q5 What are nucleophilic substitution reactions, and give examples of such reactions? Describe the mechanism of nucleophilic substitution reactions in detail. Discuss the stereochemistry involved in nucleophilic substitution reactions. **(16)**

Q6 a) Define free energy. How does it vary with temperature and pressure? **(8x2)**

b) Derive the expression for free energy change of an ideal gas.
One mole of an ideal gas at 27 °C expands isothermally and reversibly from initial volume of 2 dm^3 to a final volume of 20 dm^3 against a pressure that is gradually reduced. Calculate q, w, ΔE, ΔH, ΔA, ΔG, and ΔS.