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Total Number of Pages: 02

Course: IDD (B.Tech and M.Tech)  
Sub\_Code: 23BS1003

2<sup>nd</sup> Semester Regular/Back Examination: 2024-25

SUBJECT: Chemistry

BRANCH(S): AE, AEIE, AERO, AUTO, CIVIL, CSE, CSEAI, CSEAIML, CSEDS, CSIT, CST, ECE, EEE, ELECTRICAL, ELECTRICAL & C.E, ETC, MANUTECH, MECH, METTA, MINING, PLASTIC

Time: 3 Hours

Max Marks: 100

Q.Code: S385

Answer Q1 (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) What is penetration power? Compare the penetration power of different orbitals with a probability density plot.
- b) What is the metallic radius of an atom 'X' if the distance between two adjacent 'X' atoms in solid form is 270 pm?
- c) Calculate the entropy change when 2 moles of lead is heated from 25 °C to 30 °C. The Specific heat of lead over this temperature range is 0.03 cal.gm<sup>-1</sup>, and the atomic weight of lead is 207.
- d) Calculate the free energy change when 4 moles of an ideal gas expand from a pressure of 100 to 10 atm at 25 °C.
- e) Arrange the following in increasing order of energy and wavelength:  
X-ray, Visible, Gamma ray, Infrared, Microwave, Radiowave, Ultraviolet
- f) State the reason for a molecule being infrared active. Which of the following molecules will show a vibrational spectrum: HCl, Br<sub>2</sub>, CH<sub>2</sub>Cl<sub>2</sub>, CO<sub>2</sub>
- g) Draw the Saw horse projection and Newman projection of Ethane.
- h) Which of the conformations of cyclohexane is more stable and why?
- i) Write the difference between α- and β-eliminations.
- j) Which type of SN reaction gives an inverted product and why?

#### Part-II

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

- a) What is shielding/screening effect? How does it affect the  $Z_{eff}$ ? How does the shielding effect vary within a period and across a group?
- b) I. Define polarization and polarizing power of ions. What is the trend in polarising power for cations Be<sup>2+</sup>, Mg<sup>2+</sup>, Ca<sup>2+</sup>, Sr<sup>2+</sup>, and Ba<sup>2+</sup>? Justify your answer.  
II. How does polarization affect the covalent character? State Fajan's rule. What are the limitations of Fajan's rules in predicting covalent character?
- c) Derive the integrated form of Claypeyron – Clausius equation for liquid – vapor equilibrium. Write the significance of this equation.

d) Describe Gibbs free energy as a criterion of equilibrium and spontaneous change. Enthalpy and entropy changes of a reaction are  $40.63 \text{ kJ mol}^{-1}$  and  $108.8 \text{ J K}^{-1} \text{ mol}^{-1}$ , respectively. Predict the feasibility of the reaction at  $27^\circ\text{C}$ .

e) Derive the expression for entropy of mixing. 1 mole of  $\text{H}_2$  and 9 moles of  $\text{N}_2$  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) The equilibrium constant for the reaction  $\text{H}_2(\text{g}) + \text{S}(\text{s}) \leftrightarrow \text{H}_2\text{S}(\text{g})$  is 18.5 at 925 K and 9.25 at 1000 K. Calculate standard enthalpy of the reaction. Also, calculate  $\Delta G^0$  and  $\Delta S^0$  at 925 K.

g) Write the principle of Microwave spectroscopy. Which of the following molecules will show a microwave rotational spectrum:  $\text{H}_2$ ,  $\text{HCl}$ ,  $\text{CH}_4$ ,  $\text{CH}_3\text{Cl}$ ,  $\text{CH}_2\text{Cl}_2$ ,  $\text{SF}_6$ ,  $\text{CS}_2$ ,  $\text{SO}_2$ ,  $\text{CO}$ , and  $\text{OCS}$ . Derive the expression for radius of a diatomic molecule using the application of microwave spectroscopy.

h) Discuss the basic principle of UV-Visible spectroscopy, giving a detailed description of different types of transitions.

i) Explain electrophilic substitution reactions and discuss the mechanism of Friedel-Crafts reaction.

j) Differentiate between  
 I) Enantiomers and diastereomers.  
 II) Racemic Mixture and Meso-compounds.

k) Compare and contrast elimination reactions with substitution reactions.

i) Explain the factors affecting the stability of free radicals, including ease of formation, hyperconjugation, and resonance taking suitable example.

### Part-III

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

(16 x 2)

**Q3** a) Define electronegativity, and describe its periodicity. Discuss the different scales to express the electronegativity of elements. (8 x 2)

b) List the different applications of electronegativity with a detailed description of any four.

**Q4** What are Maxwell's relations? Write the significance. Derive the various forms of Maxwell's relations. (16)

**Q5** a) State Beer's Law. Derive an expression for the intensity of transmitted radiation when light is passed through a homogeneous solution. (4)

b) At a definite wavelength, an absorber, when placed in a cell of 1 cm path length, absorbs 20% of the incident light. If the absorptivity of the absorber at this wavelength is 2. Find out its concentration. (4)

c) 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)

**Q6** a) What is conformational isomerism? Discuss the conformational isomerism of n-butane using a potential energy diagram for various conformations of n-butane. (8 x 2)

b) Compare the stability of free radicals, carbocations, and carbanions based on their structural features.