B.Sc. in CSE, 2nd Semester Date: 23 May 2024

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF NATURAL SCIENCES

Semester Final Examination — Summer Semester: 2022-2023
Course Number: Chem 4241 — Full Marks: 300
Course Title: Chemistry — Time: 3 Hours

Answer all the **6 (Six)** questions. The symbols have their usual meanings. Marks of each question and the corresponding CO and PO are written in the brackets.

1.a) Describe hydrogen bond and its different types with examples. (7) (CO1) (PO1)

b) 'The molecules CH_4, NH_3, and H_2O all involve sp3 hybridization of the central atom, but their bond angles are 109° 28′, 107° 18′, and 104° 30′, respectively.' Justify the reason behind this. (8) (CO2) (PO2)

c) Find the shape/geometry of the following species using the VSEPR model, and comment on molecular polarity: XeF_5^+, ClF_3 (10) (CO3) (PO2)

2. a) Explain the following reactions with examples: (7) (CO1) (PO1)
(i) Substitution reaction
(ii) Condensation reaction
(iii) Esterification reaction

b) Draw the complete phase diagram for water system labeling all phase and phase transitions. Explain that the triple point for one component system is an invariant point. (8) (CO2) (PO2)

c) Calculate the bond order of O_2 molecule displaying the electronic states in various bonding and anti-bonding molecular orbitals. Is it paramagnetic? Justify your answer. (10) (CO3) (PO2)

3. a) Discuss the effect of temperature on solubility. (7) (CO1) (PO1)

b) Explain Nernst's Distribution Law. How is it modified when the solute undergoes association in one of the solvents? (8) (CO2) (PO2)

c) 0.005 Kg of NaCl is dissolved in 1000 g of water. If the density of the resulting solution is 0.997 gmL^{-1} , calculate the molality, molarity, normality and mole fraction of the solute. (10) (CO3) (PO2)

4. a) Explain the effect of temperature on the position of equilibrium and on the value of equilibrium constant. (7) (CO1) (PO1)

b) Derive an equation for pH of hydrolysis of a salt formed by a weak acid and a strong base. (8) (CO2) (PO2)

c) 2.0 moles of SO_2 and 2.0 moles of O_2 are sealed in a container at a pressure of 1.5 atm and at a suitable constant temperature. At equilibrium, $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$, 1.88 moles of SO_3 was formed. Calculate K_p of the reaction and mention its unit. (10) (CO3) (PO2)

5. a) Define boiling point. Explain with the help of vapour pressure-temperature curves why the solution has higher boiling point than the solvent. (7) (CO1) (PO1)

b) Derive thermodynamically an expression for ebullioscopic constant, K_b, from boiling point elevation. (8) (CO2) (PO2)

c) 100 mL solutions containing the same mass (2.0 g) NaCl or KCl, are taken separately into two beakers. Which solution has higher boiling point? Illustrate your answer after calculating the number of particles in each solution. (Relative atomic masses of Na, K and Cl are 23, 39 and 35.5 respectively. (10) (CO3) (PO2)

6. a) Draw and explain the molar conductance vs concentration curves for a strong and a weak electrolytes. (7) (CO1) (PO1)

b) Explain how the molar conductance of a weak electrolyte, like CH_3COOH, at infinite dilution can be determined. (8) (CO2) (PO2)

c) $NH_4^+(aq)$ ion, a weak Lewis acid, forms a buffer with NH_3. Establish a relation between pH and concentrations of these species and calculate pH of the buffer that is prepared by adding 0.80 L of 0.30 $molL^{-1}$ ammonia to 0.20 L of 0.20 $molL^{-1}$ hydrochloric acid. (Given that K_a for $NH_4^+(aq)$ is 5.0×10^{-10} at 25 ^oC). (10) (CO3) (PO2)