

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF NATURAL SCIENCES

Semester Final Examination
 Course Number: Chem 4115
 Course Title: Physical and Inorganic Chemistry

Winter Semester: 2023-2024
 Full Marks: 120
 Time: 2 Hours

Please answer according to the order of the questions. Answer all the 4 (FOUR) questions. The symbols have their usual meanings. Marks of each question and the corresponding CO and PO are written in the brackets.

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- 1 a) Explain molecular orbital theory (MOT). Apply MOT, sketch the molecular orbital diagram of CN molecule and explain the followings: (15)
 (CO2, PO2)
 (1) Bond order of CN molecule
 (2) Bond dissociation energy
 (3) Magnetic property
 (4) Stability of CN molecule.
- b) Discuss the followings: (1) Electron sea model (2) Hydrogen bond. (8)
 (CO1, PO1)
- c) Discuss the factors favoring for the formation of an ionic bonds. (7)
 (CO1, PO1)
- 2 a) Deduce an expression showing the effect of temperature on the chemical equilibrium. (15)
 (CO2, PO2)
 If the degree of dissociation of PCl_5 is α , find out an expression for equilibrium constant K_c and K_p for the following reaction.
 $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$.
- In a closed vessel of 2.0 dm^3 volume, one mole PCl_5 is heated. If 40% of PCl_5 is dissociated at equilibrium, calculate the value of equilibrium constant.
- b) Write the followings: (8)
 (CO1, PO1)
 (1) Law of mass action
 (2) Equilibrium constant K_p and K_c
 (3) Deduce the relation between K_p and K_c .
- c) Classify liquid crystals and briefly discuss them. (7)
 (CO1, PO1)
- 3 a) Define and provide examples of a rate law, rate constant and reaction rate. (15)
 (CO2, PO2)
 Give an example of a complex reaction. Write the reaction mechanism and determine the molecularity of that reaction.
 Consider the reaction, $4\text{NO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{N}_2\text{O}_5(\text{g})$
 Suppose that, at a particular moment during the reaction, molecular oxygen is reacting at the rate of 0.024 mol/L^{-1} . a) At what rate is N_2O_5 being formed? b) At what rate is NO_2 reacting?

- b) A plot of $\ln[A]$ versus time for the hypothetical reaction $A \rightarrow B + C$ yields a straight line. What is the order and unit of the rate constant of the reaction? (8)
 Show the relationship between half-life and rate constant of that reaction. (CO1, PO1)
 If half-life of that reaction is 40 minutes, then calculate the time required to complete 60% of the reaction.
- c) 21.4 mL 0.415 M benzoic acid is titrated with 0.363 M KOH. Sketch the titration curve with initial and equivalence pH. The K_a value for benzoic acid is 6.3×10^{-5} . (7)
 (CO1, PO1)
- 4 a) Define conjugate acid and conjugate base in an example. Define equivalent Conductance and molar conductance. Describe the working principle of voltaic cell. (15)
 (CO2, PO2)
- b) Derived Nernst-equation. (8)
 Calculate the cell potential of the following voltaic cell at 25 °C? (CO1, PO1)
 $Zn(s) | Zn^{2+} (0.200 M) || Ag^{+} (0.00200 M) | Ag(s)$, the reduction potential of Zn and Ag is given -0.76 V and 0.80 V, respectively.
- c) Briefly describe electroplating and corrosion. How does electroplating prevent corrosion? (7)
 (CO1, PO1)