B.Sc. Eng.IPE/1st Sem.

Date: 10 April 2026
Afternoon

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF NATURAL SCIENCES

Semester Final Examination — **Winter Semester**: 2024-2025
Course Number: Chem 4115 — **Full Marks**: 120
Course Title: Physical and Inorganic Chemistry — **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) Define lattice energy? Describe how the Born-Haber cycle can be used to derive the lattice energy of an ionic solid taking NaCl as an example. (12) CO1, PO1, WK1, WP1

b) Describe hydrogen bond and its different types with examples. (8) CO1, PO1, WK1, WP1

c) Explain molar conductance? Discuss the variation of molar conductance with concentration for both strong and weak electrolytes. (10) CO1, PO1, WK1, WP1

2. a) Define order of a reaction? Name different methods for the determination of order of a reaction. Discuss the principle for determination of order of a reaction, $A \rightarrow P$ by differential method. (15) CO1, PO1, WK1, WP1

b) Find the shape/geometry of the following species using the VSEPR model, and comment on the polarity of the species: (15) CO1, PO1, WK1, WP1

SOF_2, BeF_3^-, $POCl_3$, IF_5, O_3

3. a) A voltaic cell with a cell reaction (15) CO2, PO1, WK1, WP1

$$Tl^{3+}(aq) + 2Cr^{2+}(aq) \rightarrow Tl^{+}(aq) + 2Cr^{3+}(aq)$$

has a measured standard cell potential +1.19 V.

i. Write the two half-cell reactions and cell notation.

ii. If the reduction potential of $Cr^{3+}(aq)$ to $Cr^{2+}(aq)$ is -0.41 V, determine $E°_{red}$ for the reduction of Tl^{3+} to Tl^{+}

iii. Sketch the voltaic cell, label the anode and cathode, and indicate the direction of electron flow

b) 75 % of a reactant is consumed in a first-order reaction by 320 s. Calculate the rate constant, k. Establish a relation between k and the half-life of the reaction mathematically and show the significance of the relationship graphically. (15) CO2, PO1, WK1, WP1

4. a) Calculate the bond order of O_2^+ displaying the electronic states in various bonding and anti-bonding molecular orbitals. Is it paramagnetic? Justify. (10) CO2, PO1, WK1, WP1

b) Calculate the rate constant of an exothermic reaction at 600 °C. (Here, the activation energy is 182 kJ mol^{-1} and the rate constant is 1.57×10^{-3} s^{-1} at 700 °C). Hence, discuss the effect of temperature on the rate of exothermic reaction. (10) CO2, PO1, WK1, WP1

c) Discuss the mechanism of an acetate buffer.
Calculate the pH of a buffer solution containing 0.250 M formic acid, HCOOH, and 0.100 M sodium formate, HCOONa. K_a for formic acid is 1.8×10^{-4}. (10) CO2, PO1, WK1, WP1