

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)  
ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION  
DURATION: 3 Hours

SUMMER SEMESTER, 2015-2016

FULL MARKS: 150

**Chem 4241: Chemistry**

Programmable calculators are not allowed. Do not write anything on the question paper.  
There are 8 (eight) questions. Answer any 6 (six) of them.

Figures in the right margin indicate marks.

- a) Derive the integrated rate equation for a second order reaction  $2A \rightarrow P$  and prove that the Half-life of such a reaction is inversely proportional to the initial concentration 7+3
- b) A first order reaction is 40% complete at the end of 50mins. What will be value of the rate constant (k)? In how many minutes will the reaction be 80% complete? 8
- c) Discuss graphical and differential methods for the determination of order of a reaction. 7
- a) Derive mathematical equations which shows the relationship between Heat of reaction and Temperature at constant volume and pressure. What is the name of the equation? 9+1
- b) Define heat of neutralization and heat of solution. Classify heat of solution and define them. 4+3
- c) The heat of reaction of  $\frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g) = HCl(g)$  at  $27^\circ C$  is  $-22.1$  kcal. Calculate the heat of reaction at  $77^\circ C$ . The molar heat capacities at constant pressure and at  $27^\circ C$  for Hydrogen, Chlorine and HCl are 6.82, 7.70 and 6.80 cal/mol respectively. 8
- a) State and explain Le Chatelier's principle with suitable examples. 6
- b) Derive a mathematical equation showing the relationship between equilibrium constant and temperature. What is the graphical presentation of equilibrium constant with temperature? 9+2
- c) The equilibrium constant  $K_p$  for the reaction  $2NH_3(g) \leftrightarrow N_2(g) + 3H_2(g)$  is  $1.22 \times 10^{-3}$  at  $25^\circ C$  and 2.16 at  $225^\circ C$ . Calculate the heat change ( $\Delta H$ ) for the reaction. 8
- a) Define the terms 'paramagnetism', 'diamagnetism' and 'bond order'. 6
- b) Show through molecular energy diagram the magnetic property and bond order of  $N_2$  and  $O_2$  molecules. 14
- c) Why does ethanol boil at a higher temperature than dimethyl ether? Explain. 5
- a) Give a comparison between orbit and orbitals. 6
- b) Derive a relationship between " $K_p$ " and " $K_c$ ". Explain with suitable examples. 9
- c) Reactions with higher activation energy ( $E_a$ ) is slower. Prove this statement with the help of a mathematical equation. 10
- a) State the Van't Hoffs laws of osmotic pressure and deduce an expression to establish the relationship between the molecular weight of a solute and the osmotic pressure. 12
- b) Explain why the boiling point of a liquid rises when a nonvolatile solute is dissolved in it. 6
- c) What will be the osmotic pressure exerted by 100ml of an aqueous solution containing 1.0 gm of glucose at  $27^\circ C$ ? (Mol.weight of glucose = 180 ) 7
- a) Define and classify conductance. What is an electrochemical cell? 5
- b) Draw and explain Galvanic cell. What is salt bridge? 8
- c) State Henry's law with example. Show how the dissolution of gases in liquids are related to temperature. Give the mathematical equation and graph. 12

8. Write short notes on the followings:

- a) Heat of combustion
- b) Hydrogen bonds
- c) Hybridization
- d) Critical solution temperature
- e) Rate and Rate constant

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|--|----|
| 1. a) Define chemical potential and Gibb's free energy   | 6  |
| b) Derive a mathematical equation relating the free energy change ( $\Delta G$ ) and equilibrium constant (K). Mention the significance of the obtained equation.                            | 12 |
| c) Calculate $K_p$ for the reaction $N_2(g) + O_2(g) \leftrightarrow 2NO(g)$ at $25^\circ C$ , when the value of standard free energy ( $\Delta G^\circ$ ) is 173 KJ. Comment on the result. | 7  |
| 2. a) Name and define Chemical bonds. Give a comparative picture of Ionic and Covalent Compounds.  | 10 |
| b) Draw the molecular diagram of NO and CN and explain the bond order and magnetic properties of them.   | 10 |
| c) Show the hybridization in Carbon .  | 5  |
| 3. a) What are the fundamental particles of an atom? Describe them in brief.   | 6  |
| b) Discuss Bohr's theory of hydrogen atom. What modifications were proposed by Sommerfeld and why?   | 12 |
| c) Calculate the wave length of the first line of Balmer series.<br>[Rydberg constant = $109700 \text{ cm}^{-1}$ ]   | 7  |
| 4. a) State and explain Henry's law. What is the effect of temperature on the solubility of Gases in liquids.  | 10 |
| b) What is critical solution temperature(CST)? Draw and explain the CST diagram for the water – triethyl amine system.   | 10 |
| c) Discuss briefly hydrogen bonds with an example.   | 5  |



5. a) What is energy of activation( $E_a$ )? Derive an equation showing the relationship between temperature and rate constant ( $k$ ).
- b) Discuss the isolation and differential methods to find the order of a reaction.
- c) The value of the half-life for a first order reaction is 1000 seconds. At what time  $1/10^{\text{th}}$  of the reactant will remain unreacted ?
6. a) Define modern periodic table. Classify elements in terms of electronic configuration.
- b) Discuss the variation of properties of elements within periods and groups with reference to their (i) Ionic radii (ii) Electro negativity.
- c) What are inert gases? Discuss the uses of helium and argon. How can you prove that helium is a mono atomic gas?
7. a) Define heat of solution and heat of combustion with suitable examples. How can you determine the heat of combustion in a laboratory ?
- b) Derive mathematical equation showing the effect of temperature on the heat of reaction. Name the equation.
- c) The heat of reaction of  $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$  at  $27^\circ\text{C}$  was found to be  $-21.976 \text{ kcal}$ . What will be the heat of reaction at  $50^\circ\text{C}$ ? The heat capacities  $C_p$  at  $27^\circ\text{C}$  for  $\text{N}_2$ ,  $\text{H}_2$  and  $\text{NH}_3$  are 6.8, 6.77 and  $8.86 \text{ cal.mol}^{-1}.\text{deg}^{-1}$  respectively.
8. Write short notes:
- Isober and Isotope
  - Quantum Number
  - Relationship between " $K_p$ " and " $K_c$ "
  - Le Chatelier Principle
  - Rutherford's Atom Model