# LOYOLA COLLEGE (AUTONOMOUS) CHENNAI – 600 034

**B.Sc.** DEGREE EXAMINATION – **CHEMISTRY**

THIRD SEMESTER – **APRIL 2025**

**UCH 3503 – THERMODYNAMICS**

Date: 29-04-2025 Dept. No. Max. : 100 Marks

Time: 01:00 PM - 04:00 PM

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| | **SECTION A - K1 (CO1)** | |
| | **Answer ALL the Questions -** | **(10 x 1 = 10)** |
| **1.** | **Fill in the blanks** | |
| a) | The ideal gas equation is _____. | |
| b) | According to first law of thermodynamics, energy of the universe is _____. | |
| c) | Complete the equation, $\Delta H - T\Delta S$ = _____. | |
| d) | The equation for van't Hoff isochore is _____. | |
| e) | The arrangement of each molecule in a system at a single moment of time is _____. | |
| **2.** | **True or False** | |
| a) | Gas molecules interacting with one another is called as ideal gas. | |
| b) | The temperature at which the Joule-Thomson coefficient changes its sign is known as inversion temperature. | |
| c) | Efficiency of a heat engine is always 100%. | |
| d) | The rate of a reaction is proportional to active masses of reactants. | |
| e) | Thermodynamic probability is always less than 1. | |
| | **SECTION A - K2 (CO1)** | |
| | **Answer ALL the Questions** | **(10 x 1 = 10)** |
| **3.** | **Answer the following** | |
| a) | Define real gas. | |
| b) | What is enthalpy of formation? | |
| c) | Define entropy. | |
| d) | Give an example for an equilibrium reaction. | |
| e) | Define heat capacity. | |
| **4.** | **Match the following** | |
| a) | Density - Gibbs free energy | |
| b) | Isochoric process - Intensive property | |
| c) | Spontaneity - Volume constant | |
| d) | Reversible reaction - Perfect crystalline solid | |
| e) | Absolute zero temperature - Closed system | |
| | **SECTION B - K3 (CO2)** | |
| **Answer any TWO of the following** | | **(2 x 10 = 20)** |
| 5. | Derive the kinetic gas equation, $PV=\frac{1}{3}mnc^2$. | (10) |
| 6. | (a) Obtain the relationship between $C_p$ and $C_v$. | (5) |
| | (b) Illustrate Hess's law of heat of summation. | (5) |
| 7. | (a) Derive any two Maxwell's relation. | (5) |
| | (b) Calculate the efficiency of heat engine working between 110 °C and 25 °C. | (5) |
| 8. | (a) Derive the relationship between $K_p$ and $K_c$. | (5) |
| | (b) Apply Le-Chatelier-Braun principle and explain the conditions to increase the production of ammonia from nitrogen and hydrogen. | (5) |

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| **SECTION C – K4 (CO3)** | | |
| **Answer any TWO of the following** | | **(2 x 10 = 20)** |
| 9. | (a) Define bond energy and explain its applications. | (5) |
| | (b) Describe the Nernst heat theorem. | (5) |
| 10. | (a) Write the expression for different types of molecular velocities. | (5) |
| | (b) Derive the integrated form of Kirchhoff's equation. | (5) |
| 11. | (a) Derive Gibbs-Helmholtz equation. | (5) |
| | (b) Obtain a relationship between standard change in Gibbs free energy and $K_p$. | (5) |
| 12. | (a) Give the difference between classical thermodynamics and statistical thermodynamics. | (5) |
| | (b) Using Stirling's approximation, find the value of ln 1000! | (5) |
| **SECTION D – K5 (CO4)** | | |
| **Answer any ONE of the following** | | **(1 x 20 = 20)** |
| 13. | (a) Derive the expression for first law of thermodynamics. | (6) |
| | (b) Distinguish between state function and path function with examples. | (4) |
| | (c) Explain Joule-Thomson effect and derive an expression for Joule-Thomson coefficient. | (10) |
| 14. | (a) Construct Carnot cycle and obtain an expression for efficiency of heat engine. | (10) |
| | (b) Give the relationship between $K_p$ and $K_c$ for the following equilibrium: $N_2O_4 \rightleftharpoons 2\ NO_2$ | (5) |
| | (c) Derive the relationship between partition function and energy. | (5) |
| **SECTION E – K6 (CO5)** | | |
| **Answer any ONE of the following** | | **(1 x 20 = 20)** |
| 15. | (a) Derive van der Waals equation of state and obtain the expression for critical temperature. | (10) |
| | (b) Apply Le-Chatlier-Braun principle for the dissociation of $PCl_5$. | (5) |
| | (c) Obtain the expression for entropy of mixing of an ideal gas. | (5) |
| 16. | (a) Formulate the expression for most probable distribution for a macrostate using major assumptions of Maxwell-Boltzmann statistics. | (10) |
| | (b) Derive expressions for $\Delta U$, $\Delta H$, and W in reversible isothermal expansion of an ideal gas. | (10) |

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