# LOYOLA COLLEGE (AUTONOMOUS) CHENNAI – 600 034

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

THIRD SEMESTER – **NOVEMBER 2024**

**UCH 3503 – THERMODYNAMICS**

Date: 12-11-2024 Dept. No. Max. : 100 Marks

Time: 09:00 am-12:00 pm

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| | **SECTION A - K1 (CO1)** |
| | **Answer ALL the Questions -** **(10 x 1 = 10)** |
| **1.** | **Fill in the blanks** |
| a) | During a process, if the temperature remains constant, it is known as _____ process. |
| b) | The enthalpy of combustion will have a _____ value. |
| c) | The efficiency of a heat engine is always less than _____. |
| d) | $K_p$ and $K_c$ are related by the equation_____. |
| e) | _____law of thermodynamics helps in a calculating the absolute entropies of various substances. |
| **2.** | **Multiple Choice Questions** |
| a) | According to first law of thermodynamics,<br>(i) $\Delta E = q - W$ (ii) $\Delta E = q + W$ (iii) $\Delta H = \Delta E - W$ (iv) $\Delta H = \Delta E + W$ |
| b) | The heat of reaction at constant pressure is given by<br>(i) $\Delta E$ (ii) $\Delta H$ (iii) $\Delta G$ (iv) $\Delta S$ |
| c) | The entropy change of a spontaneous process is<br>(i) Positive (ii) Negative (iii) positive or negative (iv) Zero |
| d) | The variation of equilibrium constant with temperature is given by<br>(i) van't Hoff isotherm (ii) van't Hoff isochore<br>(iii) Law of mass action (iv) Le Chatelier's principle |
| e) | Which of the following is a fundamental concept in statistical thermodynamics?<br>(i) Activation energy (ii) Partition function<br>(iii) Electrode potential (iv) Wave-particle duality |
| | **SECTION A - K2 (CO1)** |
| | **Answer ALL the Questions** **(10 x 1 = 10)** |
| **3.** | **Match the following** |
| a) | State function - lowest entropy |
| b) | Adiabatic process - At constant volume |
| c) | $C_p$ - No transfer of heat |
| d) | $\Delta U = q$ - At constant pressure |
| e) | Crystalline solid state - Internal energy |
| **4.** | **True or False** |
| a) | Temperature is an intensive variable. |
| b) | Heat of combustion of organic compounds is an additive property. |
| c) | Free energy is given by G = E - TS. |
| d) | The equilibrium constant decreases with increase of temperature. |

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| e) | Sterling's approximation is Ln N! = NlnN + N. |

**SECTION B - K3 (CO2)**

**Answer any TWO of the following** **(2 x 10 = 20)**

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| 5. | (a) Calculate the work that must be done at 27° C on 10 moles of $CO_2$ to compress it from a volume of 100 litres to 10 litres assuming an ideal behaviour. (5)<br>(b) Explain Joule-Thomson effect. (5) |
| 6. | (a) Define bond energy. Discuss its applications. (5)<br>(b) Explain the effect of temperature on Maxwell's distribution of molecular velocities. (5) |
| 7. | (a) Explain the thermodynamic principle of refrigerator. (5)<br>(b) Derive a relationship between $K_p$ and $K_c$. (5) |
| 8. | List the major assumptions of Maxwell-Boltzmann statistics. Explain the relation between energy and partition function. (10) |

**SECTION C – K4 (CO3)**

**Answer any TWO of the following** **(2 x 10 = 20)**

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| 9. | (a) State first law of thermodynamics and deduce its mathematical expression. (5)<br>(b) Derive van der Waals equation of state. (5) |
| 10. | (a) Derive Kirchoff's equation. (5)<br>(b) Show that $C_p - C_v = R$. (5) |
| 11. | (a) Derive any two Maxwell's relations. (5)<br>(b) What is meant by a spontaneous reaction? Give any two examples. (5) |
| 12. | (a) State third law of thermodynamics and its limitations. (5)<br>(b) Derive van't Hoff isotherm. (5) |

**SECTION D – K5 (CO4)**

**Answer any ONE of the following** **(1 x 20 = 20)**

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| 13. | (a) Obtain the mathematical expression for kinetic theory of gases and deduce the gas laws from the expression. (10)<br>(b) State and explain Hess's law. Discuss its applications. (10) |
| 14. | (a) Derive Gibb's Helmholtz equation and mention its applications. (10)<br>(b) Derive $K_p$ for the following equilibrium: $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$ (5)<br>(c) State and explain Nernst heat theorem. (5) |

**SECTION E – K6 (CO5)**

**Answer any ONE of the following** **(1 x 20 = 20)**

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| 15. | (a) Summarize the postulates of kinetic theory of gases. (6)<br>(b) Define heat of neutralization and explain why the heat of neutralisation of a strong acid by a strong base is always a constant. (4)<br>(c) Describe in detail the Carnot reversible cycle for stabilising the maximum convertibility of heat into work. (10) |
| 16. | (a) State Le-Chatelier-Braun principle and apply it to explain the effect of pressure and concentration in formation of ammonia. (10)<br>(b) Explain the steps involved in the determination of absolute entropy of solids, liquids and gases. (10) |

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