MSc DEGREE EXAMINATION MAY 2026

(Third Semester)

Branch - **CHEMISTRY**

CHEMICAL KINETICS AND STATISTICAL THERMODYNAMICS

Time: Three Hours

Maximum: 75 Marks

SECTION-A (10 Marks)

Answer **ALL** questions

ALL questions carry **EQUAL** marks (10 × 1 = 10)

Module No.	Question No.	Question	K Level	CO
1	1	In ARRT, the activated complex is: a) A stable molecule b) In equilibrium with products c) In equilibrium with reactants d) A catalyst	K2	CO1
	2	In the $H_2 + Br_2$ chain reaction, the chain carrier is: a) H_2 b) Br_2 c) $Br^{\bullet}$ d) HBr	K1	CO1
2	3	Relaxation methods are used to study: a) Extremely slow reactions b) Reactions with gaseous products c) Fast reversible reactions d) Enzyme inhibition	K1	CO2
	4	Flash photolysis is particularly useful for studying: a) Enzyme kinetics b) Reaction intermediates with long half-lives c) Very short-lived intermediates d) Gas phase reactions only	K2	CO2
3	5	Which gas is commonly used in BET surface area measurements? a) Nitrogen b) Oxygen c) Hydrogen d) Carbon dioxide	K1	CO3
	6	Which step in the photochemical H_2–Cl_2 reaction is considered the chain-initiating step? a) $Cl_2 + h\nu \rightarrow 2Cl^{\bullet}$ b) $H_2 + Cl^{\bullet} \rightarrow HCl + H^{\bullet}$ c) $H^{\bullet} + Cl_2 \rightarrow HCl + Cl^{\bullet}$ d) $Cl^{\bullet} + Cl^{\bullet} \rightarrow Cl_2$	K2	CO3
4	7	Gibbs free energy is obtained using the relation: a) G=U−TS+PV b) G=H−TS c) Both A and B d) None of these	K1	CO4
	8	At high temperatures, vibrational contributions to heat capacity: a) Vanish b) Become constant c) Increase linearly d) Are negligible	K2	CO4
5	9	What does a point in phase space represent? a) A wave function b) A specific energy level c) The state of a system (position and momentum) d) An eigenvalue of a Hamiltonian	K1	CO4
	10	In statistical mechanics, equilibrium constant depends on which of the following? a) Number of moles b) Gibbs free energy and partition functions c) Temperature only d) Activation energy	K2	CO4

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ALL questions carry **EQUAL** Marks (5 × 7 = 35)

Module No.	Question No.	Question	K Level	CO
1	11.a.	Explain the concept of isokinetic temperature. How is it related to isokinetic relationships in reaction series?	K2	CO1
		(OR)		
	11.b.	What is auto-oxidation? Describe the mechanism of hydrogen auto-oxidation.		
2	12.a.	Apply the concepts of Arrhenius and van't Hoff intermediate complexes to explain the catalytic process in homogeneous systems.	K3	CO1
		(OR)		
	12.b.	Explain the mechanism of acid-base catalysis with examples. How do prototropic and protolytic mechanisms differ in terms of their catalytic pathways?		
3	13.a.	Derive the rate expression for a bimolecular reaction occurring via the Langmuir-Hinshelwood mechanism	K3	CO3
		(OR)		
	13.b.	Apply the photochemical mechanism of the H_2-Cl_2 reaction to explain the chain initiation, propagation, and termination steps.		
4	14.a.	Critically evaluate the assumptions of Maxwell-Boltzmann statistics. Under what conditions does it fail? Analyze its limitations in light of quantum statistics	K4	CO4
		(OR)		
	14.b.	Derive the translational partition function for an ideal monoatomic gas in 3D. Analyze its dependence on temperature and volume		
5	15.a.	Analyze the conceptual differences between Bose-Einstein and Fermi-Dirac statistics.	K4	CO4
		(OR)		
	15.b.	Analyze how the contribution of different degrees of freedom affects the heat capacity of a diatomic gas across temperature ranges.		

SECTION -C (30 Marks)

Answer **ANY THREE** questions

ALL questions carry **EQUAL** Marks (3 × 10 = 30)

Module No.	Question No.	Question	K Level	CO
1	16	Compare and contrast the Absolute Reaction Rate Theory (ARRT) with the Collision Theory. Analyze the conditions under which ARRT provides a more accurate prediction of reaction rates.	K4	CO1
2	17	Compare and analyze the primary and secondary salt effects on reaction kinetics.	K4	CO2
3	18	Analyze the role of radiation chemistry in biological systems and industrial applications	K4	CO3
4	19	Compare the three fundamental statistical ensembles in terms of constraints and physical applicability.	K4	CO4
5	20	Analyze the derivation of the equilibrium constant K using statistical mechanics.	K4	CO4

Z-Z-Z END