

Branch - **CHEMISTRY**

THERMODYNAMICS, ELECTROCHEMISTRY AND PHASE EQUILIBRIUM

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	What term is used to describe the effective concentration of a species in a non-ideal solution? (a) Fugacity (b) Activity (c) Chemical Potential (d) Partial Pressure	K1	CO1
	2	How is the chemical potential of a substance in a system defined? (a) The total free energy of the system (b) The heat absorbed by the system at constant pressure (c) The change in Gibbs free energy per mole of substance added at constant temperature and pressure (d) The partial pressure of the substance in a gaseous mixture	K2	CO1
2	3	What is the statement of the Third Law of Thermodynamics? (a) Energy cannot be created or destroyed (b) The entropy of the universe always increases (c) The entropy of a perfect crystal at absolute zero is zero (d) The enthalpy of a reaction is constant	K1	CO2
	4	Identify the correct Van't Hoff equation. (a) $d(\ln K_p)/dT = \Delta H^\circ/RT^2$ (b) $d(\ln K_p)/dT = \Delta S^\circ/RT$ (c) $d(\ln K_p)/dT = \Delta G^\circ/RT^2$ (d) $d(\ln K_p)/dT = \Delta H^\circ/RT$	K2	CO2
3	5	What does the Debye-Huckel limiting law relate? (a) Molar conductivity to concentration (b) Mean activity coefficient to ionic strength (c) EMF to concentration (d) Electrode potential to temperature	K1	CO3
	6	In a conductometric titration of HCl vs NaOH, what is the trend in conductance before the endpoint? (a) Increases (b) Remains constant (c) Decreases (d) First increases, then decreases	K2	CO3
4	7	Overpotential is a phenomenon primarily related to: (a) Thermodynamics of a cell (b) Kinetics of an electrode process (c) Resistance of the electrolyte (d) The potential of the reference electrode	K1	CO4
	8	Which phenomenon describes the movement of charged colloidal particles under an applied electric field? (a) Electro-osmosis (b) Electrophoresis (c) Sedimentation potential (d) Streaming potential	K2	CO4
5	9	What is the degrees of freedom for a pure substance at its triple point? (a) 2 (b) 1 (c) 0 (d) 3	K1	CO5
	10	A mixture of two substances that melts at a single, sharp temperature is called a(n) (a) Isomorph (b) Eutectic mixture (c) Congruent compound (d) Solid solution	K2	CO5

Cont...

Answer ALL questions
ALL questions carry EQUAL Marks $(5 \times 7 = 35)$

Module No.	Question No.	Question	K Level	CO
1	11.a.	Define chemical potential. Explain how the chemical potential of a system varies with changes in temperature and pressure.	K3	CO1
	(OR)			
	11.b.	Define fugacity and activity. Explain why fugacity is used instead of pressure when dealing with the thermodynamics of real gases.		
2	12.a.	State and explain the Nernst Heat Theorem and its significance in thermodynamics.	K3	CO1
	(OR)			
	12.b.	State Le Chatelier's principle. Explain its application to the synthesis of ammonia (Haber process).		
3	13.a.	Explain the Debye-Huckel theory of strong electrolytes, focusing on the concepts of ionic atmosphere and asymmetry effect.	K3	CO3
	(OR)			
	13.b.	What is a potentiometric titration? Explain the principle and procedure for the titration of a strong acid against a strong base.		
4	14.a.	What is an electrical double layer? Explain the structure of the double layer using Helmholtz-Perrin model.	K5	CO4
	(OR)			
	14.b.	Differentiate between electro-osmosis and electrophoresis. Briefly explain one application of electrophoresis.		
5	15.a.	State the Gibbs Phase Rule and briefly define each term in the equation.	K5	CO5
	(OR)			
	15.b.	Draw and explain the phase diagram of the Lead-Silver (Pb-Ag) system.		

SECTION -C (30 Marks)

Answer **ANY THREE** questions

ALL questions carry EQUAL Marks $(3 \times 10 = 30)$

Module No.	Question No.	Question	K Level	CO
1	16	Explain the concept of partial molar properties with a suitable example. Discuss Gibbs-Duhem equation.	K4	CO1
2	17	Derive the thermodynamic equilibrium constant (K_p) for an ideal gas reaction. Explain how K_p is related to the standard Gibbs free energy change.	K3	CO2
3	18	What are conductometric titrations? Discuss the titration of (i) a strong acid with a weak base and (ii) a weak acid with a strong base.	K3	CO3
4	19	What is hydrogen overvoltage? Critically analyze the theories of overvoltage and evaluate the factors that influence its magnitude.	K5	CO4
5	20	With a neat diagram, analyze the phase diagram of the water system and evaluate its significance in phase equilibria.	K5	CO5

Z-Z-Z END