ARSD College, University of Delhi

Model Course Handout/Lesson Plan

Course Name : B.Sc. (Hons) chemistry						
Semester	**Course Code**	**Course Title**	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Credit (C)**
II	DSC 2: Physical Chemistry - II	Thermodynamics and its Applications	**3**			**3**
Teacher/Instructor(s)		Dr. Neha Bhardwaj				
Session		2022-2023				

Course Objective:

- To make students understand thermodynamic concepts, terminology, properties of thermodynamic systems, laws of thermodynamics and their correlation with other branches of physical chemistry and make them able to apply thermodynamic concepts to the system of variable compositions, equilibrium and colligative properties.

Learning Outcomes

On completion of the course, the student will be able to:

• Explain and apply the three laws of thermodynamics, concept of State and Path functions, extensive and intensive properties to solve critical problems.

• Derive the expressions of ΔU, ΔH, ΔS, ΔG, ΔA for an ideal gas under different conditions and use them for solving real world problems.

• Explain the concept of partial molar properties.

Lesson Plan:

S. NO.	**Learning Objective**	**Lecture week No.**	**Topics to be covered**
I	Basic Concepts of Chemical Thermodynamics	1	Intensive and extensive variables; state and path functions; isolated, closed and open systems
		2	Mathematical treatment - Exact and inexact differential, Partial derivatives, Euler's reciprocity rule, cyclic rule
II	First law and Thermochemistry	3	Concept of heat, Q, work, W, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities
		4	

			Joule Thompson Porous Plug experiment, Nature of Joule Thompson coefficient
		5	calculations of Q, W, ΔU and ΔH for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions
		6	Enthalpy of reactions: standard states; enthalpy of neutralization, enthalpy of hydration, enthalpy of formation and enthalpy of combustion and its applications
		7	bond dissociation energy and bond enthalpy; effect of temperature (Kirchhoff's equations) on enthalpy of reactions
III	Second Law	8	Concept of entropy; statement of the second law of thermodynamics, Carnot cycle
		9	Calculation of entropy change for reversible and irreversible processes (for ideal gases)
		10	Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity (for ideal gases)
		11	Relation between JouleThomson coefficient and other thermodynamic parameters; inversion temperature
		12	Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state
IV	Third Law	13	Statement of third law, unattainability of absolute zero, calculation of absolute entropy of molecules, concept of residual entropy, calculation of absolute entropy of solid, liquid and gases.
V	Systems of Variable Composition	14	Partial molar quantities, dependence of thermodynamic parameters on composition
		15	Gibbs Duhem equation, chemical potential of ideal mixtures, Change in thermodynamic functions on mixing of ideal gases

Evaluation Scheme:

No.	Component	Duration	Marks
1.	Internal Assessment		30
	• Quiz		
	• Class Test		
	• Attendance		
	• Assignment		
2.	End Semester Examination	3 hr	90

Details of the Course		
Unit	**Contents**	**Contact**

		Hours
1 **Basic Concepts of Chemical Thermodynamics**	Intensive and extensive variables; state and path functions; isolated, closed and open systems. Mathematical treatment - Exact and inexact differential, Partial derivatives, Euler's reciprocity rule, cyclic rule.	6
2 **First law and Thermochemistry**	Concept of heat, Q, work, W, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, Joule Thompson Porous Plug experiment, Nature of Joule Thompson coefficient, calculations of Q, W, ΔU and ΔH for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. Enthalpy of reactions: standard states; enthalpy of neutralization, enthalpy of hydration, enthalpy of formation and enthalpy of combustion and its applications, bond dissociation energy and bond enthalpy; effect of temperature (Kirchhoff's equations) on enthalpy of reactions.	15
3 **Second Law**	Concept of entropy; statement of the second law of thermodynamics, Carnot cycle. Calculation of entropy change for reversible and irreversible processes (for ideal gases). Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity (for ideal gases). Relation between JouleThomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.	15
4 **Third Law**	Statement of third law, unattainability of absolute zero, calculation of absolute entropy of molecules, concept of residual entropy, calculation of absolute entropy of solid, liquid and gases.	3
5 **Systems of**	Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal mixtures, Change in thermodynamic functions on mixing of ideal	6

Variable Composition	gases.	
	Total	**45**

Suggested Books:

Sl. No.	Name of Authors/Books/Publishers	Year of Publication/Reprint
1	Peter, A.; Paula, J. de. (2011), Physical Chemistry, 9th Edition, Oxford University Press.	2011
2	Castellan, G. W. (2004), Physical Chemistry, 4th Edition, Narosa	2004
3	Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol 2, 6th Edition, McGraw Hill Education.	2015
4	Kapoor, K.L., A Textbook of Physical Chemistry, Vol 3, 5th Edition, McGraw Hill Education.	2010
5	McQuarrie, D. A.; Simon, J. D. (2004), Molecular Thermodynamics, Viva Books Pvt. Ltd.	2004

Mode of Evaluation:	Internal Assessment / End Semester Exam