Paper Name : Physical Chemistry (Theory)	Course Code : CH 403
Credits : 04	Learning Hours : 60

The objectives of this syllabus are to provide students with a comprehensive understanding of thermodynamics, reaction kinetics, surface chemistry, and polymer chemistry. This includes elucidating Nernst's heat theorem and the Third law of thermodynamics, and their applications in evaluating entropies, free energy changes, and equilibrium constants. Additionally, the syllabus aims to cover chemical affinity, methods for determining chemical affinity, and concepts of chemical potential. Furthermore, the objectives include exploring theories of reaction rates such as collision theory, transition state theory, and activated complex theory, along with their limitations. The syllabus also encompasses the study of adsorption, including physical and chemical adsorption, kinetics, experimental methods, and isotherm equations. Moreover, the objectives extend to polymer chemistry, covering radical polymerization processes, molecular weight concepts, determination methods, and viscometry. Through these objectives, students will gain a solid foundation in thermodynamics, kinetics, surface chemistry, and polymer science, preparing them for advanced studies and applications in these fields.

By the end of the course, the students will be able to:

- Achieve a deep understanding of Nernst's heat theorem, the Third law of thermodynamics, and chemical affinity, applying them effectively to analyze systems and calculate entropies, free energy changes, and equilibrium constants.
- Master theories of reaction rates, including collision theory and transition state theory, along with their limitations, gaining insight into reaction mechanisms and solvent effects on reaction rates.
- Develop a comprehensive understanding of polymerization techniques and molecular weight concepts, enabling accurate characterization of polymer samples and proficiency in analytical methods such as viscometry for molecular weight determination.
- Acquire proficiency in experimental design, data analysis, and numerical interpretation, applying theoretical principles to practical problems in thermodynamics, reaction kinetics, surface chemistry, and polymer science.

DETAILED SYLLABUS

Unit 1 Chemical Thermodynamics (14 Marks)

- Nernst heat theorem and its applications to gaseous system,
- Third law of thermodynamics and its applications to evaluate absolute entropies of solids, liquids, and gases and for calculations of free energy changes and equilibrium constants of reactions.
- Chemical affinity and its applications.
- Methods for determining the chemical affinity of a reaction-Gibbs Helmholtz equation, E.M.F. Method, Van't Hoff equation Method, Vapour pressure method, Partial molar quantities and their determination by direct method, apparent molar properties, method of intercepts.
- Chemical potential and its physical significance, variation of chemical potential with temperature and pressure, chemical potential of idea gases and solutions.
- Numericals

Unit 2 Chemical Kinetics (14 Marks)

- Introduction.
- Theories of reaction rates: The collision theory of reaction rates.
- The transition state theory of reaction rates and its limitations
- Activated complex theory in terms of thermodynamic terms.
- Elementary reactions in solutions, influence of solvent properties on rate, different types of molecular interactions in solutions, diffusion, and activation-controlled reactions.
- Transmission coefficient, reaction coordinates, potential energy surfaces, kinetic isotope effect
- Numericals

Unit 3 Surface Chemistry (14 Marks)

- Physical and chemical adsorption, Special features of chemisorption-kinetics of chemisorption and heat of chemisorption, BET theory for multilayer adsorption

- Experimental methods of determining gas adsorption-Volumetric and gravimetric method.
- Determination of surface area of adsorbents by HJ method, Benton and white method and BET Method.
- Gibbs adsorption isotherm equation, Experimental results of the Gibbs equation, verification of the Gibbs equation- Domain and Barker Method.
- The Microtome method of Mcbain. The tracer method.

Unit 4 **Polymer Chemistry** **(14 Marks)**

- **Radical Polymerization Processes**: Bulk-, Solution-, Suspension-, and Emulsion Polymerization techniques and their comparison.
- **Molecular weight of Polymers**: Introduction, Number and weight-average concepts
- Derivation of equations for number and weight average molecular weights.
- Equations for Sedimentation and viscosity average molecular weights, Molecular weight and Degree of polymerization.
- Polydispersity and Molecular weight distribution, Practical Significance of polymer molecular weight.
- List of methods of determining number averaged molecular weight , weight averaged molecular weight and molecular weight distribution.
- **Viscometry method**: Introduction, Common names of viscosity, types of capillary viscometers, Experimental procedure for determining intrinsic viscosity and the use of Mark-Houwink- Sakurada equation to calculate Mv .
- Numericals.

References

1. Essentials of Physical Chemistry, B. S. Bahl, G. D. Tuli, ArunBahl,S. Chand & Company Ltd.
2. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma and Madan S. Pathamia, Visual Publishing Co.

3. Physical chemistry by W.J.Moore, 5th edition, orient longman private ltd.

4. Textbook of physical chemistry by S. Glasstone, D. Van Nostrand company, inc., 1946.

5. Chemical Kinetics by Laidler, 3rd edition, Pearson Education India.

6. Chemical Kinetics by Laidler, 3rd edition, Pearson Education India

7. Advanced physical chemistry – by Gurdeep Raj