

Course Module for Chemistry (1+1+1, Honours)

Paper III

Thermodynamics

- 1.(i) Basic formalism concept of thermal equilibrium, heat and work. 2 Lectures
- (ii) Reversible and irreversible processes and their mathematical derivations and different processes like isothermal and adiabatic etc. 5 Lectures
- (iii) Derivatives, exact differentials, state and path functions. 4 Lectures
- (iv) Cyclic rule, zeroth law, first law of thermodynamics and their mathematical implications. 3 Lectures
- (v) Different functions like H,U, C_p , C_v and their relations, Joule's experiment. 4 Lectures
- (vi) Thermochemistry, Kirchoff's equation, heat changes etc. 2 Lectures
- 2.(i) Second law of thermodynamics and its need, Kelvin, Planck and Clausius statements and their equivalence, Carnot cycle, Carnot's theorem, Thermodynamic scale of temperature. 6 Lectures
- (ii) Physical concept of entropy, Clausius inequality, entropy change of system and surrounding for various processes and during isothermal mixing of ideal gases 5 Lectures
- (iii) Auxiliary state functions (G and A) and their variations with T, P and V, criteria of spontaneity and equilibrium, Maxwell relations, Thermodynamic equation of state, Gibb's-Helmholtz equation 4 lectures
- (iv) Joule-Thomson (J-T) experiment, inversion temperature, J-T coefficient For a Van der Waals gas, general heat capacity relations. 3 Lectures

Paper VII

1.Properties of liquids

- (i) General features of fluid flow, Reynolds number, viscous drag, streamline motion, Newton's equation, viscosity coefficient, kinetic theory of gas viscosity, viscosity of gas vs liquid., Poiseuille's equation and its derivation, temperature dependence of viscosity, determination of viscosity coefficient of liquids. 7 Lectures
- (ii) Vapour pressure, Surface energy and surface tension and its dependence on temperature and concentration, excess pressure, capillary rise, condition of wetting, determination of surface tension, concept of liquid crystal and superfluid. 9 Lectures

2. Thermodynamics and Chemical equilibrium

- (i) Additivity rule, Partial molar quantities, chemical potential and its variation with T and P, Gibbs-Duhem equation, fugacity of gases and fugacity coefficient. 4 Lectures
- (i) Thermodynamic Condition of spontaneity of a reaction and equilibrium. 3 Lectures
- (ii) Le Chatelier principle, Van't Hoff isotherm, isobar and isochores 4 Lectures

3. Thermodynamics of two-phase equilibrium and dilute solutions and colligative properties

- (i) Definition of phase, component and degree of freedom, phase rule and its derivation phase diagram of water and carbon dioxide. 8 Lectures
- (ii) Liquid vapour equilibrium for two component systems, Duhem-Margules equation, azeotropic solution, liquid-liquid phase diagrams for phenol-water, nicotine-water system, eutectic mixture, Nernst distribution law, solvent extraction. 10 Lectures
- (iii) Ideal solution and Raoult's law and Henry's law. 3 Lectures
- (iv) Clausius-Clapeyron equation, derivation and its application. 2 Lectures
- (v) Colligative properties, inter relationship, abnormal behavior in solution, Van't Hoff i-factor 7 Lectures

4. Properties of macromolecule

- (i) Addition and condensation of polymers, degree of polymerization, number and weight average, molecular weight and their relation, kinetics of polymerization. 6 Lectures
- (ii) Determination of molecular weight by osmometry and viscometry. 2 Lectures

Paper XI

Group A

1. Properties of interfaces

- (i) Surface excess and Gibbs adsorption isotherm, Langmuir and Freundlich adsorption isotherms, properties colloids, mechanism of coagulation. 6 Lectures
- (ii) Electrode double layer and zeta potential, idea of micelles and reverse micelles, critical micellization constant(CMC) 4 Lectures
- (iii) Electrical properties of molecules, polarizability, induced and orientation polarization, Debye and Clausius-Mossotti equations (without derivation) and their applications. Origin and type of intermolecular forces, different types of potential and their diagrams. 8 Lectures

2. Electrochemistry

(i) Debye-Huckel theory (with derivation) and the limiting law, ion atmosphere, asymmetric and electrophoretic effects, Wien effect and Debye-Falkenhagen effect. 6 Lectures

3. Symmetry and group theory

Introduction, symmetry elements and operations with illustrations, group and symmetry group, group multiplication table, point group, determination of molecular point group 10 Lectures

Group B

1. Quantum Chemistry

Old quantum theory

(i) Black body radiation, Planck's radiation law, photoelectric effect 3 Lectures

(ii) Wilson-Sommerfeld quantization rule, application to Bohr's theory, harmonic oscillator, particle in a one dimensional box. 4 Lectures

(iii) de Broglie relation and energy quantization in Bohr's atom and box. Heisenberg uncertainty principle, Bohr's correspondence principle and its application. 6 Lectures

Quantum mechanics

(i) Concept of operator, eigenfunction and eigenvalues, eigenvalue equation, hermitian operator, properties, construction of Hamiltonian operator, Schrodinger's time independent equation 10 Lectures

(ii) Particle in a box, setting up of Schrodinger's equation of one dim. Box, its solution, degeneracy, normality, orthogonality, probability distribution of ψ , expectation values and their significance, extension to the two and three dimensions. 10 Lectures

(iii) The H-atom problem, emergence of magnetic quantum number, concept of orbitals, shapes of s and p orbitals. 8 Lectures

2. Statistical thermodynamics and the third law

(i) Thermodynamic probability, entropy and probability, 3 Lectures

(ii) Boltzmann Distribution formula (with derivation) and application to barometric distribution, partition function and thermodynamic properties (U, H & P), Einstein's theory of heat capacity of solids and its limitations. 6 lectures

(iii) Nernst heat theorem and its implication, approach to zero Kelvin 2 Lectures

(iv) Planck formulation of the third law, absolute and residual entropies. 3 Lectures

Paper XII (Physical Practical)

Physical Chemistry experiments. 80 Lectures

1. Determination of Surface tension of unknown liquid at different concentration

2. Determination of viscosity of unknown liquid solution at different concentration

3. Determination of solubility and solubility product of a sparingly soluble salt

4. Determination of partition coefficient
5. Determination of equilibrium constant by partition method
6. Kinetic study of saponification of ester by conductometric method
7. Kinetic study of H_2O_2 decomposition with KI catalyst
8. Conductometric titration of acid-base
9. Conductometric verification of Ostwald dilution law
10. Colorimetric determination of pK_{in} of methyl red

Course Module for Chemistry (1+1+1, Pass)

Paper II

Group B (Physical Chemistry)

- Thermodynamics,
1. (i) Thermal equilibrium, first law, reversible and irreversible work, perfect gas, isothermal and adiabatic expansions, thermochemistry-Hess's law and its application, 10 Lectures
 (ii) Second law and its interpretation, Carnot cycle, criteria of spontaneity, free energy, entropy. 8 Lectures
 2. Chemical equilibrium,
 (i) Condition of equilibrium, laws of mass action, K_p and K_c , Le Chatelier principle.
 Van't Hoff isotherm, isobar and isochores 6 Lectures
 3. Phase equilibrium and colligative properties
 Phase rule equation, phase diagram of water, Miscibility(phenol-water), distillation completely miscible binary liquids, azeotropes, steam distillation. 10 Lectures
 Dilute solutions, Raoult's law, elevation of boiling point and depression of melting point, abnormal behaviour of electrolyte. 8 Lectures
 4. Properties of matter
 Viscosity of fluids, temperature and pressure dependence, surface tension and surface energy of liquids. 6 Lectures
 5. Photochemistry and spectroscopy
 Absorption, Lambert-Beer's law, photochemical laws, Laws of photochemistry, Fluorescence, phosphorescence, Jablonsky diagram, elementary idea of rotational and vibrational spectra. 8 Lectures

Paper III

Practical - Inorganic and organic qualitative analysis.

Inorganic: Silver, lead, copper, cadmium, iron, aluminium, sodium, potassium, barium, ammonium magnesium etc. and their oxides, chlorides, sulphates, phosphates, nitrates, borates etc. 15 Lectures

Organic: Detection of elements (N,Cl,S) and functional groups. 12 lectures

Paper IV

1. Macromolecular Chemistry

Introduction, Definition of macromolecules, Natural and synthetic polymers, monomers, polymers, degree of polymerization, Simple idea of polymer structure, homopolymer, copolymer, polymerization reaction step, importance of polymers.

Number and weight average molecular weights of polymers, natural and synthetic rubber, synthetic fibers, plastics like polythene and PVC, polythene. 8 Lectures

2. Medicinal Chemistry

Antipiretic and analgesics like paracetamol and aspirin, sulpha-drugs like sulphadiazine, antibiotics like peniciline and chloramphenicol, antiameobic like metronidazole.

6 Lectures

Paper IV

Practical

Inorganic Quantitative Analysis

18 Lectures

Re sources for chemistry students

1. Introduction to physical chemistry --- Cambridge Books, 3rd edition, by Mark Ladd publisher, Cambridge Univ. Press.
2. Physical Chemistry (4th ed) Walter J. Moore.
3. A text book of Physical Chemistry (2nd ed) by Arthur Adamson.
4. Atkins Physical Chemistry (8th edition)
5. Quantum Mechanics of the Chemical Bond by Peter E. Blochl-TU Clausthal, 2014.
6. Quantum Mechanics: Lecture notes on Quantum Chemistry by Eric R. Bittner-University of Houston, 2003.