PAPER: CHEMISTRY (150 MARKS)

PART-I

I. Atomic Structure and Quantum Chemistry

Electromagnetic spectrum, photoelectric effect, Bohr's atomic model, wave and particle nature of matter, de Broglie's equation, Heisenberg's uncertainty principle, wave functions and Born interpretation of wave functions, probability density, Eigen functions and Eigen values, Hamiltonian operator, Schrödinger wave equation and its solution for particle in one and three dimensional boxes.

II. Electrochemistry

Ions in solution, measurement of conductance and Kohlrausch's law, mobility of ions and transport number, conductometric titrations, Debye-Hückel theory and activity coefficient, determination of activities, Redox reactions, spontaneous reactions, electrochemical cells, standard electrode potentials, liquid junction potential, electrochemical series, Nernst's equation, measurement of pH, electrolytic cells, potentiometry, reference and indicator electrodes, fuel cells, corrosion and its prevention.

III. Thermodynamics

Equation of states, ideal and real gases, the van der Waals equation for real gases, critical phenomena and critical constants, four laws of thermodynamics and their applications, thermochemistry, calorimetry, heat capacities and their dependence on temperature, pressure and volume, reversible and non-reversible processes, spontaneous and non-spontaneous processes, Hess's law, The Born-Haber cycle, relations of entropy and Gibbs free energy with equilibrium constant, Gibbs Helmholtz equation, fugacity and activity.

IV. Chemical Kinetics

The rate and molecularity of reactions, Factors affecting rate of a chemical reaction, zero, first, second and third order reactions with same initial concentrations, half-lives of reactions, experimental techniques for rate determination of order of reaction (integration, half-life, initial rate and graphical methods), collision theory, transition state theory, Arrhenius equation and rate equations of complex reactions.

V. Surface Chemistry and Catalysis

Properties of liquids, physical and chemical properties of surface, determination of surface area. Adsorption and absorption; physical adsorption and chemisorption, adsorption isotherms, Langmuir adsorption isotherm and Fruendlich isotherm. Colloids; properties, classification and preparation of colloidal systems. Surfactants, Phase rule; Gibbs equation of phase rule, one component systems, two component systems and their examples, Catalysis; homogeneous and heterogeneous catalysis, acid-base and enzyme catalysis.

VI. Fundamentals of Chemometrics

Sampling, significant figures, stoichiometric calculations, measurement errors, analysis of variance (ANOVA), arithmetic mean, median, mode, standard

deviation/relative standard deviation, confidence limits, Gaussian distribution, least square method, Statistical tests.

VII. Separation Methods

Solvent extraction; theory of solvent extraction; solvent extraction of metals, analytical separations, multiple batch extraction and counter current distribution.

Chromatography; theory of chromatography, classification and overview of chromatographic techniques (paper, thin layer, column and ion exchange chromatographies). Principle of electrophoresis and its application as separation and characterization of proteins.

VIII. Basic Inorganic Chemistry

Types of chemical bonding, ionic and covalent bonding, localized bond approach, theories of chemical bonding, valance bond theory (VBT), hybridization and resonance, prediction of molecular shapes using valence shell electron pair repulsion (VSEPR) model, Molecular orbital theory (MOT) applied to diatomic molecules, delocalized approach to bonding, bonding in electron deficient compounds, hydrogen bonding, Physical and chemical properties of p-block elements with emphasis on oxygen, carbon, chlorine, silicon, nitrogen, phosphorus and some of their representative compounds.

IX. Acids and Bases

Brief concepts of chemical equilibrium, acid–base theories including soft and hard acid and base (SHAB) concept, relative strength of acids and bases, significance of pH, pKa, pKb and buffer solutions. Theory of indicators, solubility, solubility product, common ion effect and their industrial applications.

X. Chemistry of d and f-block elements

General characteristics of d-block elements, historical back ground of coordination chemistry, nomenclature and structure of coordination complexes with coordination number 2-10, Chelates and chelate effect. Theories of coordination complexes; Werner's theory, Valence bond theory (VBT), Crystal field theory (CFT) and Molecular orbital theory (MOT). Jahn-Teller theorem, magnetic properties, spectral properties, isomerism, stereochemistry and stability constants of coordination complexes.

General characteristics of Lanthanides, occurrence, extraction and general principles of separation, electronic structure and position in the periodic table, lanthanide contraction, oxidation states, spectral and magnetic properties and uses. General characteristics of actinides, electronic structure, oxidation state and position in the periodic table, half-life and decay law.

PART-II

I. Basic Concepts of Organic Chemistry

Bonding and orbital hybridization, Localized and delocalized bonding, Inductive effect, Dipole moment, Resonance, Hyperconjugation.

II. Saturated and Unsaturated Hydrocarbon

Nomenclature, Physical properties, Preparation and reactions of alkanes, alkenes and alkynes.

III. Chemistry of Aromatic Compounds

Benzene structure, Aromaticity, Mechanism of electrophilic substitution reaction, Activating and deactivating substituents, Effect of substituents on orientation and reactivity.

IV. Chemistry of Functional Groups

Preparation and properties of alcohols, phenols, ethers, and amines with focus on reaction mechanism and applications. Preparation and reactions of alkyl halides. Synthetic applications of Grignard reagent. Carbonyl compounds, preparations and reaction mechanism of aldehydes and ketones and their applications. Carboxylic acids and their derivatives, acidity of carboxylic acids and effect of substituents on their acidity, preparation and reactions of carboxylic acids and their derivatives including acid halides, acid anhydrides, esters and amides.

V. Aliphatic nucleophilic substitution and elimination reactions

Mechanism of nucleophilic substitution reactions. Elimination reactions, Zaitsev rule and Hofmann rule. Competition between Substitution and elimination reactions.

VI. Stereochemistry

Molecular chirality, types of stereoisomers, R S Configuration and EZ designation, Optical activity, Stereoselectivity and stereospecificity and resolution of racemic mixtures.

VII. Organic Spectroscopy

Theory, Principle, instrumentation and applications of UV/Visible, 1H NMR, IR spectroscopiy and Mass spectroscopic techniques.

VIII. Biomolecules

Carbohydrates; Monosaccharides, oligosaccharides and polysaccharides, biological functions of starch, glycogen, cellulose, and cell wall polysaccharides.

Lipids; Classification and biological importance of lipids. Significance of lipids in biological membranes and transport mechanism.

Amino Acids; classification of amino acids, physical and chemical properties of Amino acids, Biological significance.

Proteins; Classification. Properties and biological significance.Primary, secondary tertiary and quaternary structures.

Nucleic Acids; Chemical composition of nucleic acids. Structure and biological significance of nucleic acids.

Enzymes; Enzyme-substrate interactions and nature of active site, mechanism of enzyme action, kinetics of single substrate reactions, enzyme inhibition, regulatory enzymes and allosteric enzymes.

IX. Metabolism

Digestion; absorption and transport of proteins, carbohydrates, lipids and nucleic acids. Glycolysis; citric acid cycle, gluconeogenesis, glycogenesis, glycogenolysis and photosynthesis.

Biosynthesis of triglycerides, phosphides, steroids and bile acids and ketone bodies.

Biochemical reaction of amino acids: decarboxylation, deamination, transamination and transmethylation, etc., urea cycle, creatine and uric acid synthesis.

Catabolism of nucleosides, DNA polymerases and other enzymes involves in metabolism.

X. Chemical Industries

Manufacturing and processing of sugar, cement, glass, paper, fertilizers, soap and detergents.

SUGGESTED READINGS

S.No.	Title	Author
1.	Physical Chemistry, 4th ed., 2005	Silbey, R. J., Alberty, R. A., and Bawendi, M. G.
2.	Physical Chemistry – A Molecular Approach, 1st ed. 1997	McQuarrie, D. A. and Simon, J. D.
3.	Atkin's Physical Chemistry, 9th ed. 2010	Atkins, P. and Paula, J. D.
4.	Physical Chemistry, 4th ed. 1972	Moore. W. J.
5.	Modern Analytical Chemistry, 2000	Harvey, D.
6.	Quantitative Chemical Analysis, 8th ed. 2011	Harris, D.C.,
7.	Analytical Chemistry. 6th ed., 2006	Christian, G. D.
8.	CHEMOMETRICS-Statistics and Computed applications in Analytical Chemistry, 2nd ed., 2007	Matthios, O.
9.	Statistics and Chemometrics for Analytical Chemistry, 5th ed. 2005	Miller, J. and Miller, J
10.	Separation Chemistry 2004	Budhiraja, R.P
11.	Advanced Inorganic Chemistry, 6th ed. 2007	Cotton, F.A. and Wilkinson, G.
12.	Inorganic Chemistry, 4th ed. 2010	Miessler, G. L. and Tarr, D.A.
13.	Inorganic Chemistry, 5th ed. 2010	Shriver, D. and Atkins, P.

S.No.	Title	Author
14.	Textbook of Inorganic Chemistry 2013	Chaudhary, S. U.
15.	Organic Chemistry, 10th ed. 2011	Solomons, T. W. G., and Fryhle, C. B.
16.	Organic Chemistry, 6th ed. 2012	Brown, W. H., Fotte, C. S., Iverson,B.L. and Anslyn, E. V.
17.	Organic Chemistry, 8th ed. 2012	John, E. M.
18.	Introduction to Spectroscopy, 4th ed., 2009	Pavia, D. L.,Lampman, G. M., Kriz,G.S. and Vyvyan, J. R.,
19.	Spectrometric Identification of Organic Compounds 2005	Silverstein, R. M. Webster, F. X. and Kiemle, D.
20.	Organic Spectroscopy 2006	Younas, M.
21.	Stereochemistry (Basic Concepts in Chemistry) 2002	Morris, D. G.
22.	Shreve's Chemical Process Industries, 5th ed. 1984	Shreve, R. N. and Austin, G. T.
23.	Riegel's Handbook of Industrial Chemistry 2003	Riegel, E. R., and Kent, J. A.