

**Chemistry**  
**B.Sc. Part I**  
**(2009-2010 and onwards)**

The examination shall comprise three theory papers (each of three hours duration) and a practical examination.

Candidate must obtain minimum pass marks in theory and practical examination separately.

<b>Paper I: Inorganic Chemistry</b>	<b>M.M.50</b>
<b>Paper II: Organic Chemistry</b>	<b>M.M. 50</b>
<b>Paper III: Physical Chemistry</b>	<b>M.M. 50</b>
<b>Practical</b>	<b>M.M.50</b>
<b>Paper I</b>	
<b>Inorganic Chemistry</b>	<b>M.M.50</b>

**Paper I: Inorganic Chemistry**

**Unit I**

**(i) Atomic Structure**

Idea of de Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation, significance of  $\psi$  and  $\psi^2$  quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule. Electronic configurations of the elements, effective nuclear charge.

**(II) Periodic Properties**

Atomic and ionic radii, ionization energy, electron affinity and electronegativity definition, methods of determination or evaluation, trends in periodic table and applications in predicting and explaining the chemical behaviour.

**Unit II**

**(III) Chemical Bonding**

**(a) Covalent Bond-** Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. Valence shell electron pair repulsion (VSEPR) theory to  $NH_3, H_3O^+, SF_4, ClF_3, ICl_2,$  and  $H_2O$ . MO theory, homonuclear and heteronuclear (Co and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

**(b) Ionic Solids-** Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, lattice defects, semiconductors, lattice energy and Born-Haber cycle, salvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajan's rule. Metallic bond-free electron, valence bond and band theories.

**(c) Weak Interactions-** Hydrogen bonding, van der Waals forces.

**Unit III**

**(IV) s-Block Elements**

Comparative study, diagonal relationships, salient features of hydrides, salvation land complexation tendencies including their function in bio systems, an introduction to alkyls and aryls.

**(V) p-Block Elements**

Comparative study (including diagonal relationship) of groups 13-17 elements.

**Unit IV**

**(VI) p-Block Elements**

Compounds like hydrides, oxides, oxy acids and halides of group 13-16, hydrides of boran- diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicate (structural principle), tetrasulphur tetranitride, basic properties of halogens, interhalogens and polyhalides.

**(VII) Chemistry of Noble Gases**

Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds.

## PAPER II

### Organic chemistry

#### Unit I

(i) **Structure and Bonding**

Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bond, van der Waals interactions, inclusion compounds, charge transfer complexes, resonance, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding.

(ii) **Mechanism of Organic Reactions**

Curved arrow notation, drawing electron movements with arrows, half-headed and double headed arrows, homolytic and heterolytic bond breaking. Types of reagents electrophiles and nucleophiles. Types of organic reactions. Energy considerations.

Reactive intermediates – carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). Assigning formal charges on intermediates and other ionic species.

Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereochemical studies).

#### Unit II

(iii) **Stereochemistry of Organic Compounds**

Concept of isomerism. Types of isomerism.

Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization.

Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature.

Geometric isomerism—determination of configuration of geometric isomers. E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds.

Conformational isomerism—conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivatives.

Newman projection and Sawhorse formulae, Fischer and flying wedge formulae.

Difference between configuration and conformation.

(iv) **Alkanes and Cycloalkanes**

IUPAC nomenclature of branched and unbranched alkanes, the alkyl group classification of carbon atoms in alkanes. Isomerism in alkanes, sources, methods of formation (with special reference to Wurtz reaction and Kolbe reaction, physical properties and chemical reactions of alkanes.

Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity.

Cycloalkanes—nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane) theory of strainless rings.

The case of cyclopropane ring: banana bonds.

#### Unit III

(v) **Alkenes, Cycloalkenes, Dienes and Alkynes**

Nomenclature of alkenes, methods of formation, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity on alcohol dehydration. The Saytzeff rule, Hofmann elimination, physical properties and relative stabilities of alkenes.

Chemical reactions of alkenes—mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule, Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with  $KMnO_4$ . Substitution at the allylic and vinylic positions of alkenes.

Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions—1,2 and 1,4 additions, Diels- Alder reaction.

Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, metal-ammonia reductions and oxidation.

#### **Unit IV**

##### **VI. Arenes and Aromaticity**

Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus and side chain. Structure of benzene: molecular formula and Kekule structure. Stability and carbon-carbon bond lengths of benzene, resonance structure, MO picture.

Aromaticity: the Huckel rule, aromatic ions.

Aromatic electrophilic substitution—general pattern of the mechanism, role of  $\sigma$  and  $\pi$  complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel-Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction.

##### **VII Alkyl and Aryl Halides**

Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanisms of nucleophilic substitution reactions of alkyl halides,  $S_N2$  and  $S_N1$  reactions with energy profile diagrams.

Methods of formation of aryl halides, nuclear and side chain reactions. The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions.

Relative reactivities of alkyl halides vs alkyl, vinyl and aryl halides.

## PAPER III

### Physical chemistry

#### Unit I

(i) **Mathematical concepts and computers**

(A) **Mathematical concepts**

Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of functions like  $k_x, e^x, x^n, \sin x, \log x$ ; maxima and minima, partial differentiation and reciprocity relations. Integration of some useful / relevant functions; permutations and combinations. Factorials. Probability.

(B) **Computers**

General introduction to computers, different components of a computer, hardware and software, input- output devices; binary numbers and arithmetic; introduction to computer languages. Programming, operating systems.

#### Unit II

(ii) **Gaseous States**

Postulates of kinetic theory of gases, derivation of kinetic gas equation, deviation from ideal behavior, Vander Waals equation of state.

Critical Phenomena: Phenomena: PV isotherms of real gases, continuity of states, the isotherms of Vander Waals equation, relationship between critical constants and Vander waals constants, the law of corresponding states, reduced equation of state.

Molecular velocities: Root mean square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. Liquification of gases (based on joule-Thomson effect).

(iii) **Liquid State**

Intermolecular forces, structure of liquids (a qualitative description).

Structural differences between solids, liquids and gases.

Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholestric phases. Thermography and seven segment cell.

#### Unit III

(iv) **Solid State**

Definition of space lattice, unit cell.

Laws of crystallography- (i) Law of constancy of interfacial angles (ii) Law of rationality of indices (iii) Law of symmetry. Symmetry elements in crystals, Miller indices

X-ray diffraction by crystals. Derivation of Bragg equation. Determination of crystal structure of NaCl, and KCl (Laue's method and powder method).

(v) **Colloidal State**

Definition of colloids, classification of colloids.

Solids in liquids (sols): properties- kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number.

Liquids in liquids (emulsions): types of emulsions, preparation. Emulsifier.

Liquids in solids (gels): classification, preparation and properties, inhibition, general applications of colloids.

## Unit IV

(vi) **Macromolecules:** Elementary ideas about addition and condensation polymerisation, Number average and mass average molecular mass of macromolecules, Determination of molecular mass of macromolecules by Osmotic pressure, Viscosity and light scattering methods .

### Chemical Kinetics and Catalysis

Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction- concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates, mathematical characteristics of simple chemical reactions- zero order, first order, second order, pseudo order, half life and mean life. Determination of the order of reaction- differential method, method of integration, method of half life period and isolation method.

Theories of chemical kinetics: effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy.

Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects.

Catalysis, characteristics of catalysed reactions, classification of catalysis, miscellaneous examples.

**CHEMISTRY**  
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<b>Practical</b>		<b>M.M.50</b>

**Paper I –Inorganic Chemistry**

**Unit I**

**(i) Chemistry of Elements of First Transition Series**

Characteristic properties of d-block elements.

Properties of the elements of the first transition series, their binary compounds and complexes illustrating relative stability of their oxidation states, coordination number and geometry.

**Unit II**

**(ii) Chemistry of Elements of Second and Third Transition Series**

General characteristics, comparative treatment with their 3d-analogues in respect of ionic radii, oxidation states, magnetic behaviour, spectral properties and stereochemistry.

**(iii) Oxidation and Reduction**

Use of redox potential data- analysis of redox cycle, redox stability in water- Frost, Latimer and Pourbaix diagrams. Principles involved in the extraction of the elements.

**Unit III**

**(iv) Coordination Compounds**

Werner's coordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes .

**(v) Chemistry of Lanthanide Elements**

Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, lanthanide compounds.

**Unit IV**

**(vi) Chemistry of Actinides**

General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, similarities between the later actinides and the later lanthanides.

**(vii) Acids and Bases**

Arrhenius, Bronsted-Lowry, the Lux-Flood solvent system and Lewis concepts of acids and bases.

**(viii) Non-aqueous Solvents**

Physical properties of a solvent, types of solvents and their general characteristics, reactions in non-aqueous solvents with reference to liquid  $NH_3$  and liquid  $SO_2$  .

## PAPER II

### Organic Chemistry

#### Unit I

##### (i) Electromagnetic Spectrum: Absorption Spectra

Ultraviolet (UV) absorption spectroscopy – absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones.

Infrared (IR) absorption spectroscopy – molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds.

##### (ii) Alcohols

Classification and nomenclature.

Monohydric alcohols – nomenclature, methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature. Reactions of alcohols.

Dihydric alcohols—nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [  $Pb(OAc)_4$  and  $HIO_4$  ] and pinacol-pinacolone rearrangement.

Trihydric alcohols – nomenclature and methods of formation, chemical reactions of glycerol.

#### Unit II

##### (iii) Phenols

Nomenclature, structure and bonding. Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols—electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben-Hoesch reaction, Lederer- Manasse reaction and Reimer-Tiemann reaction.

#### Unit III

##### (iv) Carboxylic Acids

Nomenclature, structure and bonding, Physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation.

Methods of formation and chemical reactions of halo acids. Hydroxy acids: malic, tartaric and citric acids.

Methods of formation and chemical reactions of unsaturated monocarboxylic acids.

Dicarboxylic acids: methods of formation and effect of heat and dehydrating agents.

##### (v) Carboxylic Acid Derivatives

Structure and nomenclature of acid chlorides, esters, amides (urea) and acid anhydrides. Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution.

Preparation of carboxylic acid derivatives, chemical reactions. Mechanisms esterification and hydrolysis (acidic and basic).

##### (vi) Ethers and Epoxides

Nomenclature of ethers and methods of their formation, physical properties. Chemical reaction—cleavage and autoxidation, Ziesel's method.

Synthesis of epoxides. Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.

### **(vii) Aldehydes and Ketones**

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones using 1,3-dithianes, synthesis of ketones from nitriles and from carboxylic acids. Physical properties.

Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction.

Use of acetals as protecting group. Oxidation of aldehydes, Baeyer—Villiger oxidation of ketones, cannizzaro reaction. MPV, Clemmensen, Wolff-Kishner,  $LiAlH_4$  and  $NaBH_4$  reductions. Halogenation of enolizable ketones.

An introduction to  $\alpha, \beta$  unsaturated aldehydes and ketones.

### **Unit IV**

#### **(viii) Organic Compounds of Nitrogen**

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media. Picric acid.

Salonitroarenes: reactivity. Structure and nomenclature of amines, physical properties. Stereochemistry of amines. Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds nitriles), reductive amination of aldehydic and ketonic compounds. Gabriel-phthalimide reaction, Hofmann bromamide reaction.

Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling.

## PAPER III

### Physical Chemistry

#### Unit I

- (i) Definition of thermodynamic terms: system, surroundings etc. Types of systems, intensive and extensive properties. State and path functions and their differentials. Thermodynamic process. Concept of heat and work.  
First Law of Thermodynamics: statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and at constant pressure and their relationship. Joule's law- Joule-Thomson coefficient and inversion temperature. Calculation of  $w$ ,  $q$ ,  $dU$  &  $dH$  for the expansion of ideal gases under isothermal conditions for reversible process.  
Thermochemistry: standard state, standard enthalpy of formation-Hess's Law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermo- chemical data, temperature dependence of enthalpy. Kirchhoff's equation.
- (ii) Second law of thermodynamics: need for the law, different statements of the law Carnot cycle and its efficiency, Carnot theorem.  
Concept of entropy: entropy as a state function, entropy as a function of  $V$  &  $T$ , entropy as a function of  $P$  &  $T$ , entropy change in physical change, Clausius inequality, entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases.

#### Unit II

- (iii) Third law of thermodynamics: Nernst heat theorem, statement and concept of residual entropy. evaluation of absolute entropy from heat capacity data. Gibbs and Helmholtz functions; Gibbs function ( $G$ ) and Helmholtz function ( $A$ ) as thermodynamic quantities,  $A$  &  $G$  as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change. Variation of  $G$  and  $A$  with  $P$ ,  $V$  and  $T$ .
- (iv) **Chemical Equilibrium**  
Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Le Chatelier's principle.  
Reaction isotherm and reaction isochore- Clapeyron equation and Clausius- Clapeyron equation, applications.
- (v) **Phase Equilibrium**  
Statement and meaning of the terms- phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system- water, and Sulphur systems.  
Phase equilibria of two component system- Solid-liquid equilibria, simple eutectic –Bi-Cd,Pb-Ag systems, desilverisation of lead.  
Solid solutions- compound formation with congruent melting point (Mg-Zn) and incongruent melting point, (NaCl-H<sub>2</sub>O)  
Liquid- liquid mixtures- Ideal liquid mixtures, Raoult's law and Henry's law. Non-ideal system- azeotropes- HCl-H<sub>2</sub>O and ethanol- water systems.  
Nernst distribution law – thermodynamic derivation, applications.

#### Unit III

- (vi) **Electrochemistry-1**  
Electrical transport- conduction in metals and in electrolyte solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution.  
Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittort method and moving boundary method.

Applications of conductivity measurements: determination of degree of dissociation, determination of  $K_a$  acids, determination of solubility product of a sparingly soluble salt, conductometric titrations.

#### **Unit IV**

##### **(Vii) Electrochemistry-2**

Types of reversible electrodes- gas-metal ion, metal-metal ion, metal-insoluble salt-anion and redox electrodes. Electrode reactions, Nernst equation, derivation of cell E.M.F. and single electrode potential, standard hydrogen electrode-reference electrodes- standard electrode potential, sign conventions, electrochemical series and its significance.

Electrolytic and Galvanic cells – reversible and irreversible cells, conventional representation of electrochemical cells.

EMF of a cell and its measurements. Computation of cell EMF. Calculation of thermodynamic quantities of cell reactions ( $\Delta G$ ,  $\Delta H$  and  $K$ ),

Concentration cell with and without transport, liquid junction potential, application of concentration cells, valency of ions, solubility product, potentiometric titrations.

Definition of pH and pKa determination of pH using hydrogen. Quinhydrone and glass electrodes, by potentiometric methods.

Buffers- mechanism of buffer action, Henderson-Hassel equation. Hydrolysis of salts.

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<b>Paper I:</b>	<b>Inorganic Chemistry</b>	<b>M.M.75</b>
<b>Paper II:</b>	<b>Organic Chemistry</b>	<b>M.M. 75</b>
<b>Paper III:</b>	<b>Physical Chemistry</b>	<b>M.M. 75</b>
<b>Practical</b>		<b>M.M.75</b>

**Paper I**  
**Inorganic chemistry**

**Unit I**

**(i) Hard and Soft Acids and Bases (HSAB)**

Classification of acids and bases as hard and soft. Pearson's HSAB concept, acid-base strength and hardness and softness. Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness.

**(ii) Metal-ligand Bonding in Transition Metal Complexes**

Limitations of valence bond theory, an elementary idea of crystal-field theory crystal field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal-field parameters.

**Unit II**

**(iii) Magnetic Properties of Transition Metal Complexes**

Types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula. L-S coupling., correlation of  $U_s$  and  $U_{eff}$  values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes.

**(iv) Electron Spectra of Transition Metal Complexes**

Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series. Orgel-energy level diagram for  $d^1$  and  $d^9$  states, discussion of the electronic spectrum of  $[Ti(H_2O)_6]^{3+}$  complex ion.

**Unit III**

**(v) Thermodynamic and Kinetic Aspects of Metal Complexes**

A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, substitution reactions of square planar complexes.

**(vi) Organometallic Chemistry**

Definition, nomenclature and classification of organometallic compounds. Preparation, properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Sn and Ti, a brief account of metal-ethylenic complexes and homogeneous hydrogenation, mononuclear carbonyls and the nature of bonding in metal carbonyls.

**Unit IV**

**(vii) Bioinorganic Chemistry**

Essential and trace elements in biological processes, metalloporphyrins with special reference to haemoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to  $Ca^{2+}$ . Nitrogen fixation.

**(viii) Silicones and Phosphazenes**

Silicones and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.

## PAPER II

### Organic Chemistry

#### Unit I

##### (i) Spectroscopy

Nuclear magnetic resonance (NMR) spectroscopy.

Proton magnetic resonance ( $^1H$  NMR) spectroscopy, nuclear shielding and deshielding. Chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone.

Problems pertaining to the structure elucidation of simple organic compounds using UV, IR and PMR spectroscopic techniques.

##### (ii) Organometallic Compounds

Organomagnesium compounds: the Grignard reagents- formation, structure and chemical reactions.

Organozinc compounds: formation and chemical reactions.

Organolithium compounds: formation and chemical reactions.

##### (iii) Organosulphur Compounds

Nomenclature, structural features, Methods of formation and chemical reactions of thiols, thioethers, sulphonic acids, sulphonamides and sulphaguanidine.

#### Unit II

##### (iv) Heterocyclic Compounds

Introduction: Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole.

Introduction to condensed five and six- membered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline.

##### (v) Organic Synthesis via Enolates

Acidity of  $\alpha$ -hydrogens, alkylation of diethyl malonate and ethyl acetoacetate. Synthesis of ethyl acetoacetate: the Claisen condensation. Keto-enol tautomerism of ethyl acetoacetate.

Alkylation of 1,3-dithianes. Alkylation and acylation of enamines.

#### Unit III

##### (vi) Carbohydrates

Classification and nomenclature. Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D(+)-glucose. Mechanism of mutarotation.

Structures of ribose and deoxyribose.

An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.

##### (vii) Amino Acids, Peptides, Proteins and Nucleic Acids

Classification, structure and stereochemistry of amino acids. Acid-base behavior, isoelectric point and electrophoresis. Preparation and reactions of  $\alpha$ -amino acids.

Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis. Structures of peptides and proteins.

Levels of protein structure. Protein denaturation/renaturation.

Nucleic acids: introduction. Constituents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA.

## **Unit IV**

### **(viii) Fats, Oils and Detergents**

Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, hydrogenation of unsaturated oils. Saponification value, iodine value, acid value. Soaps, synthetic detergents, alkyl and aryl sulphonates.

### **(ix) Synthetic Polymers**

Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers.

Condensation or step growth polymerization. Polyesters, polyamides, phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes.

Natural and synthetic rubbers.

### **(x) Synthetic Dyes**

Colour and constitution (electronic concept). Classification of dyes. Chemistry and synthesis of Methyl orange, Congo red, Malachite green, Crystal violet, Phenolphthalein, Fluorescein, Alizarin and Indigo

## PAPER III

### Physical Chemistry

#### Unit I

##### (i) Elementary Quantum Mechanics

Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects, Compton effect.

De Broglie hypothesis, the Heisenberg's uncertainty principle, Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of the wave function eigen function and eigen value normalization and orthogonality of wave functions, Schrodinger equation in Hamiltonian form, solution of Schrodinger equation for a particle in one-dimensional box.

Schrodinger wave equation for H-atom, separation into three equations (without derivation). Quantum numbers and their importance, hydrogenlike wave functions, radial wave functions, angular wave functions.

Molecular orbital theory, basic ideas- criteria for forming M.O from A.O. construction of M.O's by LCAO-  $H_2^+$  ion, calculation of energy levels from wave functions, physical picture of bonding and antibonding wave functions, concept of  $\sigma, \sigma^*, \pi, \pi^*$  orbitals and their characteristics.

Introduction to valence bond model of  $H_2$  comparison of M.O. and V.B. models.

#### Unit II

##### (ii) Spectroscopy

Introduction: electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom.

##### Rotational Spectrum

Diatomic molecules. Energy levels of a rigid rotor (semi-classical principles). Selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect.

##### Vibrational Spectrum

Infrared spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups.

Raman Spectrum: concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.

##### Electronic Spectrum

Concept of potential energy curves for bonding and antibonding molecular orbitals, Qualitative description of selection rules and Franck-Condon principle.

Qualitative description of  $\sigma, \pi$  and n M.O., their energy levels and the respective transitions.

#### Unit III

##### (iii) Photochemistry

Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grothus – Drapper law, Stark – Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing). Quantum yield, photosensitized reactions- energy transfer processes (simple examples).

##### (iv) Physical Properties and Molecular Structure

Optical activity, polarization-(Clausius – Mossotti equation). Orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment-temperature method and refractivity method dipole moment and structure of molecules, magnetic properties- paramagnetism, diamagnetism and ferromagnetic.

## **Unit IV**

### **(v) Solutions, Dilute Solutions and Colligative Properties**

Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient.

Dilute solution, colligative properties, Raoult's law relative lowering of vapour pressure, molecular weight determination. Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression of freezing point, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, degree of dissociation and association of solutes.

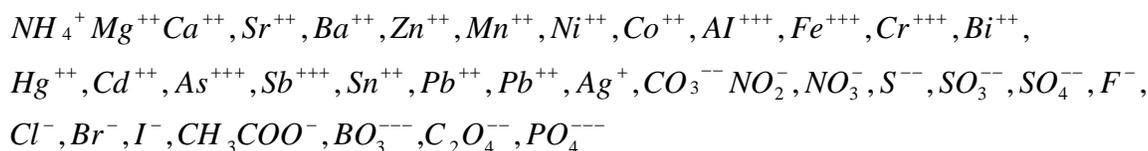
**B.Sc. Part I**  
**CHEMISTRY PRACTICAL**

**Max. Marks: 50**

**Section 1**

**M.M.20**

1. Qualitative analysis of a inorganic mixture containing five radicals out of the following, preferably by semi-micro techniques (Including insoluble substances and interfering anions )



**M.M.05**

**Section 2**

2. (a) Detection of extra elements (N, S and Halogens) and functional groups (phenolic, Carboxylic, Carbonyl, esters, carbohydrates, amines amides, nitro and anilide ) in simple organic compounds.  
(b) Determination of melting point Naphthalene, Benzoic acid, urea, succinic acid, salicylic acid, Acetanilide m-dinitrobenzene, p- dichlorobenzene.  
(c) Determination of boiling points. Ethanol, Cylohexane, Toluene, Benzene.

**Section 3**

**M.M.15**

3. Volumetric Analysis

- (a) Determination of percentage composition of  $Na_2CO_3$  And  $NaHCO_3$  in a solution.  
(b) Determination of acetic acid in commercial vinegar using  $NaOH$   
(c) Determination of alkali content in antacid tablet using HCl.  
(d) Titration of ferrous ion with dichromate using internal and external indicators.  
(e) Iodometric estimation of potassium dichromate and copper sulphate.  
(f) Estimation of hardness of water by EDTA.

**VIVA VOCE**

**M.M.05**

**RECORD**

**M.M.05**

**Total marks**

**50**

**NOTE:**

- (1) Candidates will be required to perform one experiment from each section in the annual practical examination.  
(2) The duration of practical examination will be of six hours.  
(3) At the time of examination, all regular students are required to submit a complete record of laboratory work done during the session.

**B.Sc. Part II**  
**CHEMISTRY PRACTICAL**

**Max-Marks:50**

**M.M.15**

**Section 1: Gravimetric Analysis**

- (a) Analysis of Ba as BaSO<sub>4</sub>
- (b) Analysis of Zn as ZnO
- (c) Analysis of Cu as CuSCN
- (d) Analysis of Ni as Ni (Dimethylglyoxime)

**Section 2: Chromatography**

**M.M.05**

A- Thin layer chromatography-

Determination of  $R_f$  values and identification of organic compounds.

- (a) Separation of green leaf pigments (spinach leaves)
- (b) Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5: 15)
- (c) Preparation and separation of 2, 4-dinitro-phenyl-hdrazones of acetone, 2- butanone, hexane-2 and 3 using fougine and light petroleum (40:60)

Or

B- Paper chromatography: Ascending and circular

- a- Separation of a mixture of amino acids using ninhydrin as spray agent.
- b- Separation of a mixture of D-L alanine, glycine, L-Leucine using N- butanol: acetic acid: water (4: 1:5) Spray reagent. Ninhydrin.
- c- Separation of monosaccharides, a mixture of D-galactose and D-fructose using n- butanol: acetone : water (4:5:1) spray reagent aniline hydrogen phthalate.

**Section: 3 Qualitative Organic Analysis**

**M.M.10**

Identification of an Organic compound (having not more than one functional group) through element test, functional group test determination of melting/boiling point and specific test.

**Section : 4 Physical Chemistry Experiments**

**M.M.10**

- (a) To determine the rate constant and order of reaction between acetone and iodine catalysed by mineral acid.
- (b) To study the kinetics of decomposition of iodide by hydrogen peroxide.
- (c) To determine the percentage composition of a given binary mixture (non interacting systems) by viscosity method.

- (d) To determine the percentage composition of a given binary mixture by surface tension method (acetone and ethyl methyl ketone).
- (e) To determine the solubility of Benzoic acid at different temperatures and to determine  $\Delta H$  of the dissolution process.
- (f) To determine the enthalpy of neutralization of strong acid with strong base and also the enthalpy of neutralization of weak acid/weak base with strong base /strong acid and then to calculate the enthalpy of ionization of weak acid /weak base.

**VIVA VOCE** **M.M.05**

**RECORD** **M.M.05**

**Total marks** **50**

NOTE:

- (1) Candidates will be required to perform one experiment from each section in the annual practical examination.
- (2) The duration of practical examination will be of six and half-hours.
- (3) At the time of examination, all regular students are required to submit a complete record of laboratory work done during the session.

### B. Sc. Part III

#### CHEMISTRY PRACTICAL

**Max. Mark:75**

(To be effective from session 2009-2010)

#### **Section I: Quantitative Inorganic Analysis**

**M.M.10**

- a. Colorimetric determination of metal ions-  $Fe^{3+}$ ,  $Co^{2+}$ ,  $Ni^{2+}$  &  $Mn^{2+}$ .
- b. Solvent extraction:
  - i. Separation and Determination of Iron by chloride extraction.
  - ii. Separation and Determination of Magnesium as acetyl acetone complex.
  - iii. Separation and Determination of Nickel as dimethyl glyoximate.
- a. Determination of available chlorine in Bleaching powder.
- b. Estimation of Calcium volumetrically using  $KMnO_4$  solution.
- c. Estimation of Copper volumetrically in Brass.
- d. Determination of Calcium and magnesium present together in a mixture using E.D.T.A.
- e. Separation and estimation of Mg (II) and Zn (II) by ion exchange method.

## Section 2: Inorganic Preparations

M.M.10

- Sodium Trioxalato ferrate (III)
- Ferrous sulphate from kipp's apparatus waste
- Tetraamine copper (II) sulphate
- Nickel dimethyl glyoxime complex
- Cis and Trans isomers of Potassium dioxalatodiaquo chromate (III)

## Section 3: Qualitative Organic Analysis

M.M.06

Separation and identification of organic compounds present in two component solid mixture using water /  $\text{NaHCO}_3$  /  $\text{NaOH}$  for separation.

## Section 4: Preparation of Organic Compounds

M.M.04

- Acetanilide from Aniline
- Iodoform from Ethanol and Acetone
- Metadinitrobenzene from Nitrobenzene
- Paranitroacetanilide from Acetanilide
- Parabromoacetanilide from Acetanilide
- Benzoic acid from Toluene
- Aniline from Nitrobenzene
- Metanitroaniline from Metadinitrobenzene
- 

## Section 5: Quantitative Organic Analysis

M.M.10

- Determination of acid value of a vegetable oil.
- Determination of iodine value of a vegetable oil.
- Determination of saponification value of a vegetable oil.
- Determination of percentage purity of Vitamin C in the given sample.
- Determination of percentage purity of Glucose in the given sample.

## Section 6: Physical Chemistry Experiments

M.M.20

- Determination of the strength of given acid conductometrically using standard alkali solution.
- Determination of ionization constant of a weak acid conductometrically.
- Determination of pH of a given solution using glass electrode.
- Determination of the velocity constant and order of reaction for the acid catalysed hydrolysis of methyl acetate at ethyl acetate room temperature.
- Determination of relative strengths of two acids ( $\text{HCl}$  &  $\text{H}_2\text{SO}_4$ ) by studying the kinetics of acid catalysed ester hydrolysis.

- f. Determination of the specific rotation of a given optically active compound by polarimeter.
- g. Determination of solubility product of Calcium hydroxide.
- h. Determination of molecular weight of a non-volatile solute by Beckmann's freezing point method.
- i. Determination of specific refractivity of the given liquid by Abbe's refractometer.
- j. Determination of partition coefficient of Benzoic acid between water and Benzene and to show the dimerisation of Benzoic acid in Benzene.

In addition, the students should also be made familiar with the following laboratory techniques. However, these experiments will not be included, as an exercise, in the annual practical examination.

**a. Steam Distillation (non evaluative)**

- I. Naphthalene from its suspension in water
- II. Separation of ortho and para nitrophenols.

**b. Column Chromatography (non evaluative)**

- j. Separation of fluorescein and methylene blue
- ii. Separation of leaf pigments from spinach leaves

<b>Viva Voce</b>	<b>M.M.10</b>
<b>Record</b>	<b>M.M.05</b>
<b>Total</b>	<b>75 Marks</b>

**Note:**

- (1) Candidates will be required to perform one experiment from each Section in the annual practical examination.
- (2) The duration of practical examination will be of ten and half hours spread over two days
- (3) At the time of examination, all regular students are required to submit a complete record of laboratory work done during the session.