B.Sc Part-I
CHEMISTRY

SESSION-2022-23

Scheme:
Max Marks: 150

	Duration (hrs.)	Max. Marks	Min. Pass Marks
Paper I	3	33	36
Paper-II	3	33	
Paper-III	3	34	18
Practical	5	50	

Note: Ten (10) questions are to be set taking two (02) questions from each unit. Candidates have to answer any 5 questions selecting at least one question from each unit.

CH-101 Paper I : Inorganic Chemistry
(2 hrs or 3 periods/ week)

Unit-I

Ionic Solids: Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, lattice defects, semiconductors, lattice energy and Born Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajan's rule.

Metallic bond: free electron, valence bond and band theories.

Weak Interactions: Hydrogen bonding, vander Waals forces.

Unit-II

Covalent Bond: Valence bond theory and its limitations, directional 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, H_2O.

Molecular **Orbital 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.

Unit-III

s-Block Elements: Comparative study, diagonal relationships, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls.

Periodicity of p-block elements: Periodicity in properties of p-block elements with special reference to atomic and ionic radii, ionization energy, electron affinity, electronegativity, diagonal relationship, catenation.

UNIT-IV

Some Important Compounds of p-block Elements: Hydrides of boron, diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetranitride, basic properties of halogens, interhalogens and polyhalides.

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08/02/18

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Chemistry of Noble Gases: Chemical properties of the noble gases, chemistry of Xenon, s ucture and bonding in Xenon compounds.

Unit- V

Nuclear Chemistry: Fundamental particles of nucleus (nucleons); Concept of nuclides and its representation; Isotopes, Isobars and Isotones (with specific examples); Forces operating between nucleons (n-n, p-p, & n-p); Qualitative idea of stability of nucleus (n/p ratio).
Radiochemistry: Natural and artificial radioactivity; Radioactive disintegration series; Radioactive displacement law; Radioactivity decay rates; Half life and average life; Nuclear binding energy, mass defect and calculation of defect and binding energy; Nuclear reactions, Spallation, Nuclear fission and fusion.

CH-102 Paper II :Organic Chemistry
(2 hrs or 3 periods / week)

Unit-I

Mechanism of Organic Reactions: Homolytic and heterolytic bond cleavage. Types of reagents, electrophiles and nucleophiles. Reactive intermediates - carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). Types of organic reactions. Energy considerations. Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereochemical studies).

Unit-II

Stereochemistry of Organic Compounds: Concept of isomerism, Types of isomerism. Difference between configuration and conformation. Flying wedge and Fischer projection formulae.
Optical Isomerism: Elements of symmetry, molecular chirality, enantiomers, stereogeniccentre, optical activity. Properties of enantiomers, chiral and achiral molecules with two stereogenic centres. Diastereomers, threo and erythro isomers, meso compounds. Resolution of enantiomers. Inversion, retention and racemization (with examples).
Relative and absolute configuration, sequence rules, D / L and R / S systems of nomenclature.
Geometric Isomerism: Determination of configuration of geometric isomers - cis / trans and E / Z systems of nomenclature. Geometric isomerism in oximes and alicyclic compounds.
Conformational Isomerism: Newman projection and Sawhorse formulae, Conformational analysis of ethane, *n*-butane, cyclohexane.

Unit-III

Alkanes and Cycloalkanes: IUPAC nomenclature of branched and unbranched alkyl group classification of carbon atoms in alkanes. Methods of formation (with special reference of Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids). Physical properties and chemical reactions of alkanes. Mechanism of free radical halogenation - orientation, reactivity and selectivity. Cycloalkanes - nomenclature, methods of formation, chemical reactions. Baeyer's strain theory and its limitations. Theory of strainless rings.

Alkenes, Cycloalkenes, Dienes and Alkynes: Methods of formation, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides. Regioselectivity in alcohol dehydration - the Saytzeff rule, Hoffmann elimination. Physical properties and relative stabilities

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

Classification and Nomenclature of isolated, conjugated and cumulated dienes. Structure of allenes and butadiene. Methods of formation, properties, Chemical reactions - 1,2- and 1,4-additions, Diels-Alder reaction and polymerization.

Structure and bonding in alkynes. Methods of formation. Chemical reactions - acidity of alkynes; mechanism of electrophilic and nucleophilic addition reactions; hydroboration-oxidation; metal-ammonia reduction, oxidation and polymerization.

Unit-IV

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 diagram.

Aromaticity: the Huckel rule, aromatic ions – three to eight membered.

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

Unit-V

Alkyl and Aryl Halides: Methods of formation of alkyl halides, chemical reactions. Mechanisms of nucleophilic substitution reactions of alkyl halides S_N2 and S_N1 reactions with energy profile diagrams.

Polyhalogen compounds: Chloroform, carbon tetrachloride.

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, allyl, vinyl and aryl halides.

CH-103 Paper III: Physical Chemistry
(2 hrs. or 3 Periods/week)

UNIT-I

Mathematical Concepts: Logarithmic relations, curve sketching, linear graphs and calculations of slopes, differentiation of functions like k_x, e^x, x^n, sinx and log x; maxima and minima, partial differentiation and reciprocity relations, integration of some useful/relevant functions, permutations and combinations, factorials, probability.

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.

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UNIT- II

Gaseous States: Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waals equation of state.

Critical Phenomenon: PV isotherms of real gases, continuity of states, the isotherms of van der Waals equation, relationship between critical constants and van der 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.)

UNIT- III

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.

Basic concept of X-ray diffraction by crystals. Derivation of Bragg's equation Determination of Crystal structure of NaCl and CsCl (Laue's method and powder method), band theory of solids. Defects in solids

UNIT IV

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

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

UNIT V

Chemical Kinetics: 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 reactions - differential method, method of integration, method of half-life period and isolation method.

Radioactive decay as a first order phenomenon.

Experimental methods of chemical kinetics: conductometric, potentiometric, optical methods, polarimetry and spectrophotometry. 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 bases on equilibrium constant and thermodynamic aspects.

Practical: CH -104: Laboratory Course -I

(4 hrs or 6 periods / week)

INORGANIC CHEMISTRY

Separation and identification of six radicals (3 cations and 3 anions) in the given inorganic mixture including special combinations.

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ORGANIC CHEMISTRY

Laboratory Techniques

(a) Determination of melting point (naphthalene, benzoic acid, urea, etc.); boiling point (methanol, ethanol, cyclohexane, etc.); mixed melting point (urea-cinnamic acid, etc.).

(b) Crystallization of phthalic acid and benzoic acid from hot water, acetanilide from boiling water, naphthalene from ethanol etc.; Sublimation of naphthalene, camphor, etc.

Qualitative Analysis

Element Detection (N, S and halogens). Functional group determination (unsaturation, phenolic, alcoholic, carboxylic, carbonyl, ester, carbohydrate, amine, amide, nitro) in simple organic solids and liquids.

PHYSICAL CHEMISTRY

(One of the following experiments should be given in the examination)

(i) Chemical Kinetics:

(a) To determine the specific reaction rate of the hydrolysis of methyl acetate/ ethyl acetate catalyzed by hydrogen ions at room temperature.

(b) To study the effect of acid strength on the hydrolysis of an ester.

(c) To compare the strengths of HCl and H_2SO_4 by studying the kinetics of hydrolysis of ethyl acetate.

(d) To study kinetically the reaction rate of decomposition of iodide by H_2O_2.

(ii) Viscosity, Surface Tension:

(a) To determine the viscosity/surface tension of a pure liquid (alcohol etc.) at room temperature. (using the Ostwald viscometer/stalagmometer).

(b) To determine the percentage composition of a given binary mixture by surface tension method (acetone & ethyl methyl ketone).

(c) To determine the percentage composition of a given mixture (non- interacting systems) by viscosity method.

(d) To determine the viscosity of amyl alcohol in water at different concentration and calculate the excess viscosity of these solutions.

(Instructions to the Examiners)

CHY 104: Chemistry Practical (Pass course)

Max. Marks: 50 **Duration of Exam: 5 hrs.** Minimum Pass Marks: 18

Inorganic Chemistry	
Ex.1 Separation and identification of 3 cations and 3 anions in the mixture	15
Organic Chemistry	3
Ex.2 Laboratory Techniques	
Ex. 3 Qualitative Analysis	10
Detection of element and detection of functional group	
Physical Chemistry	12
Ex. 4 Perform one of the experiments mentioned in the syllabus.	5
Ex. 5 Viva-voce	5
Ex. 6 Record	50
Total	

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B.Sc. Part II, [redacted]

Chemistry

Scheme:

Max Marks: 150

	Duration (hrs.)	Max. Marks	Min. Pass Marks
Paper I	3	33	
Paper-II	3	33	36
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Practical	5	50	18

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CH-201 Paper I: Inorganic Chemistry

(2 hrs or 3 Periods/week)

Unit- I

Chemistry of Element 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.

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 behavior , spectral properties and stereochemistry.

Unit-II

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.

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Unit-III

Chemistry of Lanthanide and Actinide Elements:

Electronic structure. Oxidation states. Ionic radii and lanthanide contraction. Complex formation occurrence and isolation of lanthanide compounds.

General features. Chemistry of separation of Np, Pu and Am from Electronic configuration oxidation states magnetic properties. Complexation behavior, comparison of lanthanides and actinides. super heavy elements.

Unit IV

Oxidation and Reduction:

Uses of Redon Potential data. Analysis of redox cycle. Redox stability m water frost. Latimer and Pourbaix diagrams Application of redox data in the extraction of elements.

Unit –V

Acids and Bases:

Theories : Arrhenius. Bronsted- Lowry, Lux-Flood, Solvent system concept and Lewis concept of acids and bases.

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.

CH-202 Paper-II: Organic Chemistry

(2 hrs. or 3 periods/week)

Unit-I

Electromagnetic Spectrum : An introduction

Absorption Spectroscopy

Ultraviolet (UV) spectroscopy- Absorption laws (Beer- Lambert law , molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions. Effect of solvents on transitions, effect of conjugation shifts. UV spectra of conjugated and enones.

Infrared (IR) spectroscopy – Molecular vibrations, Hook's law .selection rules, intensity and position of IR bands. Measurement of IR spectrum , fingerprint region, characteristics absorption of various functional groups and interpretation of simple organic compounds.

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Unit-II

Alcohols – Classification and nomenclature .

Monohydric alcohols- Methods of formation by reduction of aldehydes, ketones carboxylic acids and esters. Hydrogen bonding . Acidic nature, Reactions of alcohol with mechanism. Dihydric alcohols – methods of formations. Chemical reactions of vicinal glycols, oxidative ,Trihydric alcohols method of formation. Chemical reactions of glycerol.

Phenols- Nomenclature structure and bonding Preparation of Phenols Physical properties and acidic character, comparative acidic strength of alcohols and phenols. Reactions of phenols electrophilic aromatic substitution. Acylation and carboxylation Mechanism of Fries rearrangement. Claisen rearrangement. Gatterman synthesis. Hauben reaction, Lederer-Manasse reaction and reamer- Tiemann reaction.

Ethers and Epoxides – Method of formation. Physical properties. Chemical reactions-cleavage and autooxidation Ziesel's method.

Synthesis of epoxides , Acid and base catalyzed ring opening of epoxides, orientation of epoxides ring opening reaction of Grignard and organolithium reagents with epoxides

Unit- III

Aldehydes and Ketones: Structure of the carbonyl group. Syntheses of aldehydes from acid chlorides synthesis of aldehydes and ketones using 1,3-dithianes. Syntheses 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 Witting reaction , Mannich reaction. Oxidation of aldehydes , Baeyer – Villiger oxidation of ketones . Cannizzaro reactions MPV (Meerrvein– Pondrof –Verlay), Clemmensen, wolf-Kishner, $LiAlH_4$ and $NaBH_4$ Reductions Halogenation of enolizable Ketones. Use of acetals and 1,3-dithiane as protecting group.

Unit –IV

Carboxylic Acids

Structure and bonding, physical properties. acidity of carboxylic acids, effects of substituens on acid strength, preparation of carboxylic acids. Reactions of carboxylic acids, Hello- Volhard – Zelinsky reaction. Reduction of carboxylic acids. Mechanism of decarboxylation.

Methods of formations and chemical reactionsof halo acids. Hydroxy acids- malic tartaric and citric acids.

Dicarboxylic acids: Methods of formations and effect of heat and dehydrating agents (succinic, glutaric and adipic acids).

Carboxylic Acid Derivatives

Structure nomenclature and synthesis of acid chlorides, esters, amides and acid anhydrides. Relative stability of acyl derivatives. Physical properties. Interconversion of acid derivatives by nucleophilic acyl substitution.

Preparation of carboxylic acid derivatives. Chemical reaction, mechanisms of esterification and hydrolysis (acidic and basic)

Unit V

Organic compounds of Nitrogen

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

Amines structure nomenclature and preparation of alkyl. And aryl amines (reduction of nitro compounds nitriles) reductive amination of aldehydic and ketonic compounds. Physical properties stereochemistry of amines. Separation of a mixture of primary , secondary and tertiary amines Structural features effecting basicity of amines. Amines salts as phase –transfer catalysis.Gabriel phthalimide reaction and Hoffmann bromamide reaction with mechanism.

Reactions of amines electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid diazotization and mechanism synthetic trans formations of aryl diazonium salts. a/o coupling and its applications.

CH-203 Paper III : Physical Chemistry

(2 hrs. or 3 periods/week)

Thermodynamics-I

Definition of Thermodynamic Terms : System surrounding 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 pressure and pressure and their relationship. Joule's law, Joule-Thomson coefficient and inversion temperature. Calculation of w.q. du & dh for the expansion of neutralizion. Bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy. Kirchoff's equation.

Unit –II

Thermodynamics –II

Second Law of Thermodynamics : Need for the law , different statements of the law. Cannot cycle and its efficiency, Carnot- Theorm. Thermodynamic scale of temperature.

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 inquality and entropy as criteria of spontancity and equilibrium. Entropy change in ideal gases and mixing of gases.

Third Law of Thermodynamics : Nernst heat theorcm, 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 ass criteria of thermodynamic equilibrium and spontaneity . their advantage over entropy change. Variation of G and A with P, V and T.

Chemical Equibrium:

Equilibrium constant and free energy. Thermodynamic derivation of law of mass action Le Chatelier's principal. Reaction Isotherm and reaction isochore. Clapeyron equation and Clausius-Clapeyron equation, applications.

Unit –III

Phase Equilibrium: Statement and meaning of the terms: phase component and degree of freedom, derivation of Gibbs phase rule, phase equilibra of one component system –water, Co_2, and Sulphur systems.

Phase equilibria of two component system - solid- liquid equilibria simple eutectic Bi-Cd, Pb-Ag, systems. Desilverization of lead.

Solid soluctions- Compound formation with Congruent melting point (Mg-Zn)and incongruent melting point. (NaCl-H_2O) systems. Freezing mixture acetone- dry ice.

Liquid- Liquid mixtures: Ideal liquid mixture. Raoult's and Henry's Law, Non ideal system- azcotropes HCl-H_2O and ethanol –water systems. Partially miscible liquids : phenol –water lower distribution law thermodynamic derivation. Application.

Unit IV

Electrochemistry-I

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 (elementary treatment only). Transport number, definition and determination by Hittorf's method and moving boundary method.

Applications of conductivity measurements :

Determination of degree of dissociation, determination of K_a of acids, determination of solubility product of sparingly soluble salt. Conductometric titrations.

Unit- V

Electrochemistry- II

Types of reversible electrodes : Gas- metal- ion, metal – insoluble salt anion and redox electrode, potential, standard hydrogen electrode, reference electrodes 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. Computations of cells EMF. Calucation of thermodynamic quantities of cell reactions ($\Delta G, \Delta H$ and K), Polarization, over potential and hydrogen over voltage .

Concentration cell with and without transport, liquid junction potential application of concentration cells. Valency of ions solubility product and activity coefficient, potentiometric titrations. Definitions of pH and pk_a determination of pH using hydrogen quinhydrone and glass electrodes by potentionetric methods.

Suggested Books:

1. Principles of Physical Chemistry : B.R. Puri, Sharma and M.S. Pathania
2. A Text Book of Physical Chemistry : A.S. Negi and S.C. Anand,
3. A Text Book of Physical Chemistry : Kundu and Jain
4. The elements of Physical Chemistry : P.W. Atkins Oxford.
5. University General Chemistry : C.N.R. Rao, Mac Millen

CH-204 Chemistry Practical (Pass Course), Laboratory Course-II

(4 hrs. or 6 periods/week)

Inorganic Chemistry

(i) Preparation of Standard Solutions

Dilution – 0.1 M to 0.001 M solutions

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(ii) Volumetric Analysis

(a) Determination of acalic acid in commercial vinegar using NaOH

(b) Determination of alkah content in antacid tablet using HCl

(c)Estimation of calcium content in chalk as calcium oxalate by permanganometer

(d) Estimation of hardness of water by EDTA

(e) Estimation of ferrous and fenric by dichromate method

(f) Estimation of copper using thiosulphate

(iii) Gravimetric Analysis

(a) Cu as CuSCN

(b) Ni as Ni (dimethylglyoxime)

Organic Chemistry

(i)Laboratory Techniques

A. Thin Layer Chromatography

Determination of R_T values and identification of organic compounds.

a) Separation of green leaf pigments (spinch lesves may be used).
b) Preparation and separation of 2, 4-dinitrophenylhydrazones of acetone, 2-butanone hexan-2-one and hexon-3-one using toluene and light petroleum (40-60) solvent System.
c) Separation of a mixture of dyes using cyclohexane and ethyl acetate(8.5:1.5)

B. Paper Chromatography : Ascending and Circular

Determination of R_f values and identification of organic compounds.

(a) Separation of mixture of phenylalanine and glycine. Alanine and asparitic acid. Leucine and glutamic acid. Spray reagent –ninahydrin.

(b)Separation of a mixture of DL- alanine, glycine and L-Leucine using n- butanol acetic acid : water (4:1:5),Spray reagent – ninhydrin.

(c) Separation of monosaccharides a mixture of D- galactose ans D- Fructose using n-butanol : acetone : water (4:5:1)Spray reagent aniline hydrogen phthalate.

(ii) Qualitative Analysis

Identification of two organic compounds (one solid and one liquid)through the functional group analysis determination of melting point, boiling point and preparation of suitable derivatives

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Physical Chemistry SESSION-2022-23

(i) Transition Temperature

(a) Determination of the transition temperature of the given substance by thermometric dialometric method (e.g. $MnCl_2 4H_2O/SrBr_2.2H_2O$).

(ii)Thermo chemistry

a) To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process.

b)To determine the enthalpy of neutralization of weak acid/weak base versus strong base /strong acid and determine the enthalpy of ionization of the weak acid weak base .

c) To determine the enthalpy of soluction of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-haber cycle.

(iii) Phase Equilihrium

a) To study the effect of a solute (e.g. NaCl succinic acid)on the critical soluction temperature of two partially miscible liquid (e.g. phenol- water system) and to determine the concentration of that solute in the given phenol water system.

b) To construct the phase diagram of two components (e.g. diphenylamine benzophenone) systems by cooling curve method.

(iv) Distribution law

a) To study the distribution of iodine between water and CCl_4.

b)To study the distributton of benzoic acid between benzene and water

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(Instructions to the Examiner)

B.Sc. Part II

CH-204 Chemistry Practical (Pass Course)

Max.Marks: 50 **Duration of Exam : 5 hrs.** **Min. Pass Marks: 18**

Inorganic Chemistry

Ex.1 Volumetric Analysis

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Or

Giravimetric Analysis as mentioned in the syllabus 16

Organic Chemistry

Ex.2 Identification of two organic compounds (one solid and one liquid)through the functional group analysis, determination of melting point, boiling point and preparation of suitable derivaties.

Or

Perform one experiment out of the experiments on thin layer and paper chromatography given in syllabus. 12

Physical Chemistry

Ex.3 Perform one of the physical chemistry experiments as mentioned in the syllabus 12

Ex. 4 Viva – voce 5

Ex.5 Record 5

50

Books Suggested (Theory Course)

1. Basic Inorganic Chemistry F.A. Cotton: G.Wilkinson and P.L. Caus Wiley.
2. Concise Inorganic Chemistry .J.D.Lee. ELBS
3. Concepts Inorganic Chemistry B. Doughts. D. Me Danial and J. Alexander
4. Inorganic Chemistry. D.F. Shriver P.W. Atkins and C.H. Langford .Oxford .
5. Inorganic chemistry. W.W. Porterfield Addison Wesley
6. Inorganic Chemistry. A.G. Sharpe EI BS
7. Inorganic Chemistry. G.I. Miessler and D.A. Tarr. Prentice Hall
8. Organic Chemistry. Morrison and Boyd. Prentice Hall
9. Organic Chemistry. L.G. Wade ji Prentice Hall
10. Fundamental of Organic Chemistry. Solomons. John Wiley.
11. Organic chemistry Vol. I,II,III S.M. Mukher ji, S.P. Singh, and R.P. Kapoor, Wiley Eastern Ltd. (New Age International)
12. Organic Chemistry, F.A. Carey, McGraw Hill, Inc.
13. Introduction to Organic Chemistry, Strecitwicscr. Heathcock and Kosover, Macmilan
14. Physical Chemistry.G.M. Barrow. International Student Edition, McGraw Hill
15. Basic Programming with Application, V.K. Jain Tata McGraw Hill

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16. Computer and common Sense. R. Hunt and Shelly, Prentice hall
17. University General Chemistry, C.N.R. Rao Macmillan
18. Physical Chemistry. R.A. Alberty, Wiley Eastern Ltd.
19. The Elements of Physical Chemistry , P.W. Atkins, Oxford
20. Physical Chemistry Through Problems, S.K. Dogra and S. Dogra Wiley Eastern Ltd.

Books Suggested (Laboratory Course)

1. Vogel's Qualitative inorganic Analysis, Revised, Svehla, Orient Longman
2. Vogel's Textbook of quantitative inorganic Analysis (revised) J. Bassett. R.C. Deneoy, G.H. Jeffery and J. Mendham .ELBS.
3. Standard Methods of Chemical Analysis. W.W. Scott. The Technical Press
4. Experimental Inorganic Chemistry , W.G. Palmer, Cambridge.
5. Handbook of preparative Inorganic Chemistry. Vol. I& II Braver, Academic Press.
6. Inorganic Synthesis. McGraw Hill
7. Experimental Organic Vol. I&II P.R. Singh, D.S. Gupta and K.S. Bajpai, Rata McGraw Hill
8. Laboratory Manual in Organic Chemistry, R.K. Bansal, Wiley Eastern.
9. Vogal's Textbook of Practical Organic Chemistry, RS. Furniss. Hannaford, V.Rogers.
10. Experiments in General Chemistry, C.N.R. Rao and U. C. Agrawal. East –West Press
11. Experiments in Physical chemistry, R.C. Das and B. Behra. Tata McGraw Hill
12. Advanced Practical Physical Chemistry, J.13. Yadav, Goel Publishing House
13. Advanced Experimental Chemistry. Vol. 1- Physical. J.N. Gurtii and R. Kapoor. S.Chand& Co.
14. Selected Experiments in Physical Chemistry, N.G. Mukharjee. J.N. Ghjose & sons.
15. Experiments in Physical Chemistry, J.C. Ghosh, Bharti Bhavan.

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अकादमिक प्रभारी
महाराजा सूरजमल बृज विश्वविद्यालय
भरतपुर (राज.)

Academic
M.S. Brij University
Bharatpur

BSc Part - III

CHEMISTRY
Scheme

SESSION-2022-23

Max Marks: 150

	Duration (hrs)	Max. Marks	Min. Pass Marks
Paper I	3	33	
Paper-II	3	33	36
Paper-III	3	34	
Practical	5	50	18

Note: Ten (10) questions are to be set taking two (02) questions from each unit. Candidates have to answer any 5 questions selecting at least one question from each unit.

CH-301 Paper-I : Inorganic Chemistry
(2 hrs or 3 periods/ week)

Unit-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.

Unit-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.

Magnetic properties of Transition Metal Complexes:
Types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μ_s, and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.

Unit-III

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.

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.

Unit-IV

Organometallic Chemistry:
Definition, nomenclature and classification of organometallic compounds. Preparation,

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properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Sn and Ti, a brief account of metalethylenic complexes and homogeneous hydrogenation, mononuclear carbonyls and the nature of bonding in metal carbonyls.

Unit-V

Bioinorganic Chemistry:
Essential and trace elements to 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.

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

CH-302 Paper-II : Organic Chemistry
(2 hrs or 3 periods/week)

Unit-I

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 NMR 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 NMR data.

Organic Synthesis via Enolates: Acidity of α-hydrogens in reactive methylene compounds, alkylation of diethyl malonate and ethyl acetoacetate. Claisen condensation, Keto-enoltautomerism in ethyl acetoacetate. Synthetic applications of ethyl acetoacetate and malonic ester.

Unit-II

Heterocyclic Compounds
Introduction: Molecular orbital diagram and aromatic characteristics of pyrrole, furan, thiopheneand 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 heterocyles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher-indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis, Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline.

Unit—III

Carbohydrates
Classification and nomenclature, Monosaccharides, mechanism of osazone formation. Epimers, anomers and mutarotation. Interconversion of glucose and fructose, chain lengthening and chain

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shortening of aldoses. Erythro and threodiastereomers. Conversion of glucose into mannose. Configuration of monosaccharides. Determination of ring size of monosaccharides. Formation of glycosides, ethers and esters. Cyclic structure of D(+)-glucose and fructose. Structures of ribose and deoxyribose.

Nomenclature and structure of disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose); Glycosidic linkage.

Unit-IV

Amino Acids, Peptides, Proteins and Nucleic Acids

Classification, structure and stereochemistry of amino acids. Acid-base behaviour, isoelectric point and electrophoresis. Preparation and reactions of α-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.

Nucleic acids – Introduction, constituents of nucleic acids - nucleosides and nucleotides.

Unit-V

Organosulphur Compounds : Nomenclature, structural features, methods of formation and chemical reactions of thiols, sulphonic acids, sulphonamides and Sulpha drugs: sulphaguanidine, sulphadiazine (sulphapyrimidine), sulphamethoxazole, sulphacetamide.

Synthetic Polymers : Addition or chain-growth polymerization. Free radical and ionic polymerization. Ziegler-Natta Catalyst Condensation or step-growth polymerization. Polyesters, polyamides, phenol-formaldehyde resins, urea-formaldehyde resins, epoxy resins and polyurethanes. Natural and synthetic rubber.

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.

CH-303 Paper III: Physical Chemistry

(2 Hrs. or 3 periods/week)

UNIT-I

Elementary quantum Mechanics:

Black-body, radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's mode 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

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the wave function, postulates of quantum mechanics, particle in a one dimensional box.

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

UNIT-II

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 level from wave functions, physical picture of bonding and antibonding wave functions, concept of σ, σ^*, π, π^* orbitals and their characteristics. Hybrid orbitals - sp, sp^2, sp^3, calculation of coefficients of A.O.'s used in these hybrid orbitals.
Introduction to valence bond model of H_2, comparison of M.O. and V.B. models.

UNIT-III

Spectroscopy
Introduction: Electromagnetic radiation, spectrum, basic features of different spectrometers, statement of the Born-Openheimer approximation, degrees of freedom.
Rotational Spectrum: Diatomic molecules, Energy levels of a rigid rotator (semi-classical principles), selection rules, spectral intensity, using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotator, 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: Basic principles and applications, 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 Frank Condon principle. Qualitative description of σ, π and n M.O. their energy levels and the respective transitions.

UNIT-IV

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 exited sate, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions-energy transfer processes (simple examples).

Physical Properties and Molecular Structure
Optical activity, polymerization – (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.

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UNIT-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 vapor 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 in freezing point. Thermodynamic derivation of relation between molecular weight and elevation of boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, degree of dissociation and association of solutes.

Practical: CH-304: Laboratory Course – III
(6 hrs/week)

INORGANIC CHEMISTRY
Synthesis and Analysis of:
a) Potassium trioxalatoferrate (III), $K_3[Fe(C_2O_4)_3]$
b) Bis (dimethylglyoximato) nickel (II) complex, $[Ni(DMG)_2]$
c) Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4$
d) Potassium *cis*-diaquabis(oxalato)chromate (III) dihydrate, $K[cis\text{-}Cr(H_2O)_2(C_2O_4)_2].2H_2O$

Instrumentation
Calorimetry
(a) Job's
(b) Mole-ration method
Adulteration-Food stuffs
Effluent analysis water analysis

Solvent Extraction
Separation and estimation of Mg (II) and Fe (II)

Ion Exchange Method
Separation and estimation of Mg (II) and Fe (II)

ORGANIC CHEMISTRY
Laboratory Techniques

Steam Distillation
Naphthalene from its suspension in water
Clove oil from Clove
Separation of o- and p-nitrophenols

Column Chromatography
Separation of fluorescein and methylene blue
Separation of leaf pigments from spinach leaves
Resolution of racemic mixture of (+) mendelic acid

Qualitative Analysis
Analysis of an organic mixture containing two solid components using water, $NaHCO_3$, for separation and preparation of suitable derivatives.

Synthesis of Organic Compounds
(a) Acetylation of salicylic acid, aniline, glucose and hydroquinone,

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Benzoylation of aniline and phenol

(b) Aliphatic electrophilic substitution
Preparation of iodoform from ethanol and acetone

(c) Aromatic electrophilic substitution
Nitration
Preparation of m-dinitrobenzene
Preparation of p-nitroacetanilide
Halogenation
Preparation of p – bromoacetanilide
Preparation of 2, 4, 6 – tribromophenol

(d) Diazotizatoin / coupling
Preparation of methyl orange and methyl red

(e) Oxidation
Preparation of benzoic acid from toluene

(f) Reduction
Preparation of aniline from nitrobenzene
Preparation of m-nitroaniline from m-dinitrobenzene.

Stereochemical Study of Organic Compounds via Models
R and S configuration of optical isomers.
E, Z configuration of geometrical isomers.
Conformational analysis of cyclohexanes and substituted cyclohexanes.

PHYSICAL CHEMISTRY

Electrochemistry

(a) To determine the strength of the given acid condcutometrically using standard alkali solution.
(b) To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically.
(c) To study the saponification of ethyl acetate conductometrically.
(d) To determine the ionization constant of a weak acid conductometrically.
(e) To titrate potentiometrically the given ferrous ammonium sulphate solution using $KMnO_4/K_2Cr_2O_7$ as titrant and calculate the redox potential of Fe^{++}/Fe^{+++} system on the hydrogen scale.

Refractometry, Polarimetry

(a) To verify the law of refraction of mixture (e.g. of glycerol and water) using Abbe's refractometer.
(b) To determine the specific rotation of a given optically active compound.

Molecular Weight Determination

(a) Determination of molecular weight of a non-volatile solute by Rast method/Beckmann freezing point method.
(b) Determination of the apparent degree of dissociation of an electrolyte (e.g. NaCl) in aqueous solution at different concentrations by ebullioscopy.

Colorimetry

(a) To verify Beer-Lambert law $KMnO_4/K_2Cr_2O_7$ and determined the concentration of the given solution of the substance.

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CH-304 Chemistry Practical (Pass Course)

Max. Marks: 50 **Duration of Exam:5 hrs.** **Minimum marks: 18**

Inorganic Chemistry

Synthesis and Analysis of **one** of the four syntheses given in the syllabus.

OR

Separation and estimation of Mg (II) and Fe (II) by solvent extraction method.

OR

Separation and estimation of Mg (II) and Fe (II) by ion exchange method. 10

Organic Chemistry

(1) Synthesis of one of the six organic preparations. 8

(2) Analysis of an organic mixture containing two solid components using water / $NaHCO_3$/ NaOH and preparation of suitable derivatives.

OR

Column chromatography techniques.

Perform one of the *three* column chromatography experiments given in syllabus. 10

Physical Chemistry

Perform one of the physical chemistry experiments given in the syllabus. 12

Viva-voce 5

Record 5

50

Books Suggested (Theory Course)

1. Basic Inorganic Chemistry F.A. Cotton. G. Wilkinson and P.L. Caus. Wiley.
2. Concise Inorganic Chemistry, J.D. Lee, ELBS
3. Concepts of Models of Inorganic Chemistry B. Douglas. D. McDaniel and J. Alexander, John Wiley.
4. Inorganic Chemistry, D.E. Shriver P.W. Atkins and C.H. Langford, Oxford.
5. Inorganic Chemistry, W.W. Porterfield Addison Wesley.
6. Inorganic Chemistry, A.G. Sharpe, ELBS
7. Inorganic Chemistry, G.L. Miessler and D.A. Tarr, Prentice Hall.
8. Organic Chemistry, Morrison and Boyd, Prentice Hall.
9. Organic Chemistry, L.G. Wade Ji. Prentice Hall.
10. Fundamentals of Organic Chemistry, Solomons, John Wiley.
11. Organic Chemistry Vol. 1, 11, III S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International)
12. Organic Chemistry, F.A. Carey, McGraw Hill, Inc.
13. Introduction to Organic Chemistry. Streitwieser. Heathcock and Kosover. Macmilan.
14. Physical Chemistry, G.M. Barrow. International Student Edition, McGraw Hill.
15. Basic Programming with Application, V.K. Jain. Tata McGraw H ill.
16. Computers and Common Sense. R. Hunt and Shelly, Prentice Hall.

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17. University General Chemistry, C.N.R. Rao, Macmillan.
18. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
19. The Elements of Physical Chemistry, P.W. Atkins, Oxford.
20. Physical Chemistry Through problems, S.K. Dogra and S. Dogra, Wiley Eastern Ltd.

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Books Suggested (Laboratory Courses)

1. Vogel's Qualitative inorganic Analysis, revised, Svehla, Orient Longman.
2. Vogel's Textbook of Quantitative Inorganic Analysis (revised), J. Bassett. R.C. Dene0y, G.H. Jeffery and J. Mendham. ELBS.
3. Standard Methods of Chemical Analysis. W.W. Scott. The Technical Press.
4. Experimental Inorganic Chemistry, W.G. Palmer, Cambridge.
5. Handbook of preparative Inorganic Chemistry. Vol [& II, Braver, Academic Press.
6. Inorganic Synthesis, McGraw Hill.
7. Experimental Organic Vol I & II, P.R. Singh, D.S. Gupta and K.S. Bajpai, 'rata McGraw Hill.
8. Laboratory manual in Organic Chemistry, R.K. Bansal, Wiley Eastern.
9. Vogel's Textbook of Practical Organic Chemistry, RS. Furniss, Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, ELBS.
10. Experiments in General Chemistry, C.N.R. Rao and U.C. Agarwal, East-West Press.
11. Experiments in Physical Chemistry, R.C.Das and B. Behra, Tata McGraw Hill
12. Advanced Practical Physical Chemistry, J.I3. Yadav, Goel Publishing House.
13. Advanced Experimental Chemistry, Vol. 1-Physical, J.N. Gurtii and R. Kapoor, S. Chand & Co.
14. Selected Experiments in Physical Chemistry, N.G. Mukerjee. J.N. Ghjose& Sons.
15. Experiments in Physical Chemistry, J.C. Ghosh, Bharati Bhavan. (Instructions to examiners)

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