B.SC.(HONS.)PART-I CHEMISTRY

Scheme of Examination for B.Sc.(Hons.)Part-I Chemistry

Paper No.	Paper Name	Max. Marks	Duration
I	Inorganic Chemistry	75	3 Hrs.
II	Organic Chemistry	75	3 Hrs.
III	Physical Chemistry	75	3 Hrs.
IV	Instrumental Methods of Analysis	75	3 Hrs.
V	Practicals	100	10 Hrs. (Distributed over two days)
	Grand Total	**400**	

PAPER-I INORGANIC CHEMISTY

Duration 3 hrs. **Max. Marks: 75**

Note: Each theory paper is divided into three independent units. The question paper is divided into three parts Part-A, Part-B and Part-C. Part-A(15 marks) is compulsory and contains 10 questions (20 words) at least three questions from each unit, each question is of 1.5 mark. Part-B (15 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of 3 marks (50 words). Part-C (45 marks) contains six questions two from each unit. Candidate is required to attempt three questions one from each unit. Each question is of 15 marks (400 words).

Unit-I

A. Atomic Structure

Idea of de Brogile matter waves. Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation, significance of ψand ψ^2, quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s. p, d orbitals. Aufbau and Pauli exclusion principles, Hunds multiplicity rule. Electronic configuration of the elements, effective nuclear charge.

B. Chemical Bonding

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_2 , H_3O^+,SF_4,CIF_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. Comparison of valence bond and molecular orbital theories.

Unit-II

A. Periodic Properties

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

B. s-Block Elements

Comparative study, diagonal relationships, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, and introduction to alklys and aryls.

C. p-Block Elements

Comparative study (including diagonal relationship) of groups 13-17 elements compounds like hydrides,oxides and halides of groups 13-16, hydrides of boron-diborane and higher boranes, borazine, borohydrides. Carbides, silicons and their industrial applications. Oxyacids and halides of sulphur, peracids of sulphur oxides and oxy acids of halogens.

Unit-III

A. Ionic Solids-

Ionic structures, radius ratio 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. Defects in crystal structures.

B. Weak Interactions- Hydrogen bonding, van der Waals forces.

C. Fullerenes, carbides, fluorocarbons, silicates (Structural principle), tetrasulphur tetranitride, basic properties of halogens, interhalogens and polyhalides.

D. Chemistry of Noble Gases

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

E. Chemistry of organometallic compounds of Lithium, Zinc, Tin and Lead.

PAPER-II ORGANIC CHEMISTRY

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Unit-I

A. Structure and Bonding

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

B. 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 example). Assigning formal charges on intermediates and other ionic species.

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

C. 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.

Unit-II

A. Alkanes and Cycloalkanes

IUPAC nomenclature of branched and unbranched alkanes, the alkyl groups, classification of carbonatoms in alkanes. Isomerism in alkanes, sources, methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids), 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.

B. Alkenes

Nomenclature of alkenes, methods of formation, mechanism of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in 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, 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. Industrial applications of ethylene and propene.

C. Cycloalkenes, Dienes and Alkynes

Methods of formation, conformation and chemical reactions of cycloalkenes

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 reaction, hydroboration-oxidation, metal-ammonia reductions, oxidation and polymerization.

Unit-III

A. 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 bond lengths of benzene, resonance structure, MO picture.

Aromaticity: the Huckle rule, aromatic ions.

B. Aromatic electrophilic substitution- general pattern of the mechanism, role of σ and π 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.

C. Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl.

D. Alkyl and Aryl Halides

Nomenclature and classes of alkyl halides, Methods of formation, chemical reaction. 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 halides vs allyl, vinyl and aryl halides Synthesis and uses of DDT and BHC.

PAPER-III PHYSICAL CHEMISTRY

Duration 3 hrs. **Max. Marks: 75**

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Unit-I

A. 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 language. Programming, operating systems.

B. 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-II

A. Gaseous States

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

Critical Phenomena: PV isotherms of real gases, continuity of states, the isotherms of van der Waals equation, relationship between critical constant 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. Liquefaction of gases (based on Joule Thomson effect).

B. Liquid State

Intermolecular forces, structure of liquids (a qualitative description)

Structural differences between solids, liquids and gases.

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

Unit-III

A 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.

X-ray diffraction by crystals. Derivation of Bragg equation. Determination of crystal structure of NaCI, KCI and CsCI (Laue's method and powder method). Insulators, semi conductor and super conductors.

Catalysis, Characteristics of catalyzed reactions, classification of catalysis, miscellaneous example, enzyme catalysis.

B. Solutions, Dilute Solutions and Colligative Properties

Ideal and non-ideal solutions, methods of expressing concentration 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 in freezing point. Experimental methods for determining various colligative properties.

Abnormal molar mass, degree of dissociation and association of solutes.

PAPER-IV INSTURMENTAL METHODS OF ANALYSIS

Duration 3 hrs. **Max. Marks: 75**

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Unit-I

A. Atomic Absorption Spectrometry: Principle and instrumentation, application, determination of arsenic, cadmium and mercury in industrial waste, lead copper and iron in sewage effluents, boron in water, iron and magnesium in blood.

B. Flame photometry: Principle, instrumentation and applications.

C. Electrochemical Methods of Analysis: D.C. Polarography: Basic principle, types of currents, dropping mercury electrodes, experimental technique, half wave potential, ilkovic equation (no derivation), cathodic wave equation, maxima and its suppression, application in qualitative and quantative analysis of alloys, mixtures and organic compounds. Normal pulse polarography.

Unit-II

A. High performance liquid chromatography (HPLC): Basic principle mode of separation, instrumentation with particular reference to pumps, injector columns, detectors, integrators, recorders, comparison with GLC analytic applications.

B. Gas Liquid Chromatography: Introduction, Choice of system, instrumentation, applications, qualitative and quantitative analysis.

C. Gel Permeation or Size Exclusion Chromatography: Introduction, theory and application.

D. Ion Exchangers: Introduction, types cationic, anionic, chelating and liquid ion exchangers, preparation, action and properties of exchangers and application of ion exchangers.

E. Solvent Extraction: Introduction, principle, factors enhancing solvent extraction, ion association complexes, applications of solvent extraction.

F. Zone Electrophoresis: Introduction, factors affecting ionic migration, detection of separated components and applications of zone electrophoresis.

Unit-III

A. Thermogravimetry (TG) and Derivative Thermogravimetry (DTG): Principle, technique and instrumentation, types of balance, factors influencing TG curves, application to analysis and kinetics.

B Differential Thermal Analysis (DTA): Principle, technique and instrumentation, factors influencing DTA curves, applications.

C. Differential Scanning Calorimetry (DSC): Principle, technique and instrumentation, comparison with DTA, Factors, Influencing DSC curves and applications.

D. Radio Analytical Method of Analysis: Law of radio active decay, detection of radiations, types of measuring instruments, principle of operation and uses, G.M. tubes and their characteristics, ionization chamber, proportional counters, scintillation counter, solid state detectors, calibration of counting equipments, determination of absolute disintegration rates.

E. Active Analysis: Principle, various methods of activation methodology, advantage, limitations and applications, isotopic dilution analysis and radio immunoassay analysis.

BOOKS RECOMMENDED:

1. Fundamentals of Molecular Spectroscopy G.M. Banwell, McGraw Hill, N.Y. 1972
2. Introduction to Molecular Spectroscopy G.M. Barrow, McGraw Hill N.Y. 1972
3. Spectroscopy and Molecular Structure G.W. king. Hold Richart and Winston, N.Y. 1964
4. Molecular Structure and Dynamic W.H.Glygare, Prentice Hall, 1978
5. Spectroscopy, Vols, I&II walkerand H. Straw, Chapman and Hall 1962
6. Molecular Spectroscopy J.D. GraybealMcGraw Hill 1988
7. Guide to Activation Analysis, W.S. Lyon Jr.D. Van Nostrand Company.
8. Instrumental Methods of Chemical Analysis, G.W. Ewing McGraw Hill Book Company inc. 1975
9. Polarographic. Technique by Miltes L. (Interscience Publishers.)
10. Treatise on Analytical Chemistry, Part I Vol.5 Ed. I M. Kolthoff and Irving Interscience Publishers, 1964
11. Modern Methods of Chemical Analysis at R.L. Pecsokand, L.D. Shields, John Wiley and Sons Inc.
12. A Text Book of Quantitative Inorganic Analysis, A.I. Vogel, Longman.
13. Analytical Chemistry S.M. Khopkar.
14. Inorganic Thermogravimetric Analysis Duval.
15. Thermal Analysis T. Danrels.
16. Differential Analysis Mackenzie.
17. Solvent Extraction in Analytical Chemistry, G.H. Morrison and Fresier, John Wiley and Sons Inc.
18. Exchange and Solvent Extraction. J.M. Marinsky and Y. Parcus, Marcel and Deccar
19. Exchange and Separation in Analytical Chemistry, O. Samuelson, John Wiley and Sons Inc.
20. Polarography by Kolthoff I. M. and Lingane.J. (Interscience publishers)

PAPER-V

PRACTICAL

Max. Marks: 100 **Time: 10 Hours**

Practicals

1. Inorganic Chemistry

Semimicro Analysis- Separation and identification of six ions cation analysis from Groups I, II, III, IV, V and VI. anion analysis including interfering radicals.

2. Organic Chemistry

(A) Laboratory Techniques. (Any six)

(a) Calibration of Thermometer

80-82^{o} (Naphthalene), 113.5^{o} -114^{o} (Acetanilide),
132.5-133^{o}(urea), 100^{o} (Distilled Water)

(b) Determination of Melting Point

(Naphthalene), 80-82^{o}, Benzoic acid 121.5-122^{o},
Urea 132.5-133^{o} Succinic acid 184.5-185^{o}
Cinnamic acid 132.5-133^{o}, Salicyclic acid 154.5-158^{o},
Acetanilide 113.5-114^{o} , m-Dinitrobenzene 90^{o}
p-Dichlorobenzene 52^{o}, Aspirin 135^{o}

(c) Determination of boiling points

Ethanol 78^{o}, Cyclohexane 81.4^{o}, Toluene 110.6^{o},Benzene 80^{o}

(d) Mixed melting points

Urea-Cinnamic acid mixture of various composition (1:4,1:1, 4:1)

(e) Distillation

Simple distillation of ethanol-water mixture using water condenser. Distillation of nitrobenzene and aniline using air condenser

(f) Crystallization

Concept of induction of crystallization,
Phthalic acid from hot water (using fluted filter paper and stemless funnel)
Acetanilidefrom boiling ethanol

Benzoic acid from water

(g) Decolorisation and crystallization using charcoal

Decolorisation of brown sugar (sucrose) with animal charcoal using gravity filtration. Crystallization and decolorisation of impure naphthalene (100 g of naphthalene mixed with 0.3 g if Congo Red using 1 g decolorizing carbon) from ethanol.

(h) Sublimation (Simple and Vacuum)

Camphor, Naphthalene, Phthalic acid and Succinic Acid.

(B) Qualitative Analysis

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.

(C) Quantitative Analysis: Separation of cations and anions by

(i) Paper Chromatography
(ii) Column Chromatography-Ion exchange
(iii) Isolation of caffeine from tea leaves.
(iv) Isolation of casein from milk (the students are required to try some typical colour reactions of proteins).
(v) Isolation of piperine from black pepper.

3. PHYSICAL CHEMISTRY *(ANY FIVE)*

1. To determine the specificreaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature.
2. To study the effect of acid strength on the hydrolysis of an ester.
3. To compare the strengths of HCl and H_2SO_4 by studying the kinetics of hydrolysis of ethyl acetate.
4. To study kinetically the reaction rate of decomposition of iodide by H_2O_2.
5. To study the distribution of iodine between water and CCl_4
6. To study the distribution of benzoic acid betweenbenzene and water.
7. To prepare arsenious sulphide sol and compare the precipitating power of mono-,bi- and trivalent anions.

8. To determine the percentage composition of a given mixture (non interacting systems) by viscosity method.
9. To determine the viscosity of amyl alcohol in water at different concentrations and calculate the excess viscosity of these solutions.
10. To determine the percentage composition of a given binary mixture by surface tension method (acetone & ethyl methyl ketone).

Distribution of Marks **Max. Marks: 100**

Inorganic

Semimicro Analysis-30 (05 marks each for one ion)(No negative marking)

Organic

(A)	Three laboratories techniques	-	15 each (15x3=45)
(B)	Qualitative Analysis		
	Two functional Groups	-	08
(C)	Qualitative Analysis		
	One experiment	-	07

Physical

	One experiment is to be performed	-	25
	Viva	-	10
	Record	-	05