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

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

Paper No.	Paper Name	Hours/ week	Max. Marks	Min.Pass Marks	Duration
I	Inorganic Chemistry	3	75		3 Hrs.
II	Organic Chemistry	3	75	120	3 Hrs.
III	Physical Chemistry	3	75		3 Hrs.
IV	Environmental Chemistry	3	75		3 Hrs.
V	Practicals	6	100	40 (Distributed in two days)	10 Hrs.
	Grand Total		**400**		

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).

PAPER-I INORGANIC CHEMISTY

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

Unit-I

A. 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.

B. Metal Ligand Bonding

Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes, π-bonding and molecular orbital theory.

C. 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.

Unit-II

A. Metal π-Complexes:

Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls, preparation, bonding, structure and important reactions of transition metal nitrosyl.

B. 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.

C. Chemistry of Lanthanide Elements

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

D. 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.

Unit-III

A. 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.

B. Acids and Bases

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

C. 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

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

Unit-I

A. 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. Bathchromic, 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 absorption of various functional groups and interpretation of IR spectra of simple organic compounds.

B. Ethers and Epoxides

Nomenclature of ethers and methods of their formation, physical properties. Chemical reactions-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.

Unit-II

A. 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.

B. 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-Hooesch reaction, Lederer-Manasse reaction and Reimeer-Tiemann reaction.

C. 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-Zeinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acid-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.

D. Carboxylic Acid Derivatives

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

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

Unit-III

A. Aldehydes and Ketones

Nomenclature and structure of 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 acid. 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.

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 $\alpha_2\beta$ unsaturated aldehydes and ketones.

B. Nucleic Acids: Purine and pyrimidine basis of nucleic acids, base pairing via H-bonding, Structure of ribonucleic acids (RNA) and

deoxyribonucleic acids (DNA), double helix model of DNA and force responsible for holding it.

C. 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. Picricacid. Halonitroarenes: 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. Gabrielphthalimide reaction, Hofmann bromamide reaction.

Reaction of amines, electrophilic aromatic substitution in aryl amines, reaction of amines with nitrous acid. Synthetic transformation of aryl diazonium salts, azo couplilng.

D. Enzymes

Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification.

PAPER-III PHYSICAL CHEMISTRY

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

Unit-I

A. Thermodynamics-I

Definition of thermodynamic terms: system, surroundings etc. Type 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 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 and adiabatic 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.

B. Thermodynamics-II

Second law of thermodynamics: need for the law, different statements of the law. Carnot cycle and its efficiency, Carnot theorem. 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 inequality, entropy as criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases.

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 with A with P, V and T.

C. Partition Function- Translation, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition functions. Applications of partition functions.

Unit-II

A. 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 Clausisus- Clapeyron equation, applications.

B. 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, CO_2 and S 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_2O), ($FeCl_3$-H_2O) and $CuSO_4$-H_2O) system. Freezing mixtures, acetone-dry ice.

Liquid- liquid mixtures- ideal liquid mixtures, Raoult's and Henry's law on-ideal system-azeotropes- HCl-H_2O and ethanol – water systems.

Partially miscible liquids- Phenol-water trimethylamine, nicotine-water systems.

Lower and upper consolute temperature. Effect of impurity on consolute temperature.

Immiscible liquids, steam distillation.

Nernst distribution law-thermodynamic derivation, applications

Phase equilibria of three component systems-liquid-liquid equilibria.

Unit-III

A 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, Arrehenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law its uses and limitations.

Debye-Huckel-Onsagar's equation for strong electrolytes (elementary treatment only).

Transport number, definition and determination by Hittorf method and moving boundary method.

Applications of conductivity measurements: determination of degree of dissociation, determination of K_2 of acids, determination of solubility product of a sparingly soluble salt, conductometric titrations.

B. Electrochemistry-II

Types of reversible electrodes-gas-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(ΔG, ΔH 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.

Definition of pH and pK, determination of pH using hydrogen, quinhydrone and glass electrodes, by potentiometric methods.

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

Corrosion-types, theories and methods of combating it.

Theory of Indicators.

PAPER-IV ENVIRONMENTAL CHEMISTRY

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

Unit-I

A. Air Pollutants and Control: Definition & sources of air pollution, air quality standards, classification of air pollutants, effects and control of CO, SO_2, NO_2 hydrocarbons, particulate matter, aerosols and automobile, exhaust air pollution.

B. Air Analysis: Criteria for sample selection, techniques used for air sampling and methods for analysis for the determination of CO, NO_2, SO_2, HC & particulate.

Unit-II

A. Water Pollutants and Control: Sources of water, physico-chemical characteristics of water, drinking water, quality standards, sources effect & control of water pollution and major pollutants-sewage, fertilizers, detergents, pesticides, heavy metal, oil & petroleum products, radioactive substances, disinfectants, nitrogen compounds NO_3, NO_2 & nitrosamines.

B. Water Analysis: Methods for sampling of water, standard methods for water and waste water analysis.

Unit-III

A. Soil Chemistry, Pollutants & Analysis: Soil profile chemical and physical, concept and source of cation exchange capacity in soils, water soluble salts in saline and alkaline soils, fertility management of soils, soil pollution sources- waste, sludge, heavy metals, effects of pollutants on plant growth. Determination of organic carbon, organic matter, pH, electrical conductivity and total soil constituents.

B Chemical Toxicology: Toxic chemical in the environment. Biochemical effects of As, Cd, Pb, Hg, Carbon monoxide, Sulphur dioxide, Nitrogen Oxide, Ozone, Cynide and Pesticides.

BOOKS RECOMMENDED:

1. Essential Environmental Science Methods & Techniques, Simon Wassls and B. Halliwell, T.R. Publication Private Ltd. Chennai, 1996.
2. The Comprehensive Hand Book of Hazardous Materials Regulations Handling, Monitoring and safety, Lewis Publishers, Boca Raton, 1994.
3. Hazardous Air Pollutants, Howard J. Beim, Jennifer Spew, Louis Theodou, Van Nostrand Reinhold, 1998
4. Water Pollution, Conversion and Management, A. K. Sinha, Ram Boojh and P. N. Vishwanathan, Gyanodaya Prakashan, Nainital 1989.
5. Environmental Chemistry- A.K. De. John Wiley.

PAPER-V
PRACTICAL

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

Inorganic Chemistry

A. Calibration of fractional weights, pipettes and burettes. Preparation of standard solution. Dilution 0.1 M to 0.001 M solutions.

B. **Quantitative Analysis**

Volumetric Analysis (Any Four)

i. Determination of acetic acid in commercial vinegar using NaOH.
ii. Determination of alkali content-antacid tablet using HCl.
iii. Estimation of calcium content in chalk as calcium oxalate by permanganometry.
iv. Estimation of hardness of water by EDTA
v. Estimation of ferrous and ferric by dichromate method.
vi. Estimation of copper using thiosulphate.

Gravimetric Analysis

i. Analysis of Cn as CuSCN
ii. Ni as Ni– di methyl glyoxime

C. Preparations (Any Four)

i. $VO(acac)_2$
ii. $Mn(acac)_3$
iii. $K_3[Fe(C_2O_4)_3]$
iv. Prussian Blue, Turnbull's Blue
v. $Hg[Co(SCN)_4]$
vi. $[Ni(dmg)_2]$
vii. $[Ni(NH_3)_6]Cl_2$

Organic Chemistry

(A) Chromatography. (Any Four)

i. Separation, R_f values and identification of organic compounds.

ii. Preparation and separation of 2,4-dinitrophenylhydrozone of acetone, 2-butanone, hexan-2- and 3-one using toluene and light petroleum (40:60).

iii. Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5)

iv. Separation of a mixture of phenylalanine and glycine, Alanine and aspartic acid. Leucine and glutamic acid. Spray reagent-ninhydrin.

v. Separation of a mixture of D,L- alanine, glycine and L-Leucine using n-butanol:acetic acid: water (4:5:1) spray reagent- ninhydrin.

vi. Separation of monosachharides- a mixture of D-galactose and D-frutose using n-butanol:acetone: water (4:5:1) spray reagent-aniline hydrogen phthalate.

(B) Qualitative Analysis

Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.

(C) Quantitative Analysis:

(i) Determination of iodine, saponication values of an oil sample.

(ii) Determination of COD and BOD of water sample

PHYSICAL CHEMISTRY (ANY SEVEN)

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

2. To study the effect of a solute (e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenol-water system) and to determine the concentration of that solute in the given phenol-water system.
3. To construct the phase diagram of two component (e.g. diphenylamine-benzophenone) system by cooling curve method.
4. To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process.
5. To determine the enthalpy of neutralisation of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionisation of the weak acid/weak base.
6. To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born Haber cycle.
7. Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically.
8. Determination of the strength of strong and weak acids in a given mixture conductometrically.
9. Determination of the strength of strong and weak acids in a given mixture using a potentiometer/pH meter.
10. Determination of rate constant for hydrolysis/inversion of sugar using a polarimeter.

Scheme of Examination (B.Sc. Hons. Pt.II) Max. Marks: 100

Inorganic

A. Calibration & Preparation of solution - 05

B. Volumetric Analysis (One)	-	10
C. Gravimetric Analysis (One)	-	10
D. Preparation (One)	-	10

Organic

A. Chromatography (One exercise)	-	10
B. Qualitative Analysis (One compound)	-	10
C. Quantitative Analysis (One exercise)	-	10

Physical

One experiment is to be performed	-	20
Viva	-	05
Record	-	10