UNIVERSITY OF DELHI

SCHEME OF EXAMINATION

AND

COURSES OF READING

FOR

B. Sc. (HONS.) CHEMISTRY

Part I 2001 Examination 2002

Part II 2002 Examination 2003

Part III 2003 Examination 2004

Syllabi applicable for the Students seeking admission to B.Sc. (Hons.) Chemistry Course in the Academic Year 2001-2002

Price : 20.00

THE COURSES OF STUDY FOR B.Sc. (Honours) CHEMISTRY FOR THE SESSION 2000-2001

SCHEME OF EXAMINATION

PART I

Theory	Paper No.	Duration (Hrs.)	Max. Marks
I	Inorganic Chemistry-1	3	50
II	Organic Chemistry-1	3	50
III	Physical Chemistry-1	3	50
IV	Mathematics-1	3	75
V	Physics-1	3	50
VI	Option (a) : Biology for Chemists	3	50
OR			
VI	Option (b) : Environmental Chemistry	3	75
Q1	English (Qualifying)*	3	100

PRACTICALS :

LAB I : Chemistry — 10 — 75

2 papers, 2 days, 5 hours each; 15 marks are reserved for Laboratory record and assessment by the class teachers of the day to day laboratory work of the candidates.

15 marks are reserved for viva-voce examination based on laboratory experiments and techniques. (Marks are divided equally between the three components (inorganic, organic and physical chemistry) of work.

LAB II : Physics — 4 — 25

(Lab record : 5 marks, viva-voce : 5 marks)

LAB III : Biology (When paper VI (option a) is offered) — 3 — 25

(Lab Record : 5 marks, viva-voce : 5 marks)

Total marks (Part-I) 450

PART II

Theory Paper No.

VII	Inorganic Chemistry -2	3	50
VIII	Organic Chemistry -2	3	50
XI	Physical Chemistry-2	3	50
X	Mathematics-2	3	75
IX	Physics-2	3	50
XII	Option (a) : Computers and their application to chemistry	4	75
OR			
XII	Option (b) : Enterpreneurship and small business	3	75

PRACTICALS

LAB IV : Chemistry — 12 — 75

2 Papers, 2 days, 6 hours each Lab record : 15 marks, viva-voce 15 marks; The marks are divided equally between the three components (Inorganic, Organic and Physical chemistry) of work.

LAB V : Physics — 4 — 25

(Lab record : 5 marks, viva-voce : 5 marks)

Total marks (Part II) 450

PART III

Theory Paper No.

XIII	Inorganic Chemistry-3	3	50
XIV	Inorganic Chemistry-4	3	50
XV	Organic Chemistry-3	3	50
XVI	Organic Chemistry-4	3	50
XVII	Physical Chemistry-3	3	50
XVIII	Physical Chemistry-4	3	50

PRACTICALS

LAB - VI : Chemistry 18 150

3 Papers, 3 days, 6 hours each; Lab record : 30 marks, viva-voce : 30 marks; marks are divided equally between the three components (Inorganic, Organic and Physical chemistry) of work.

Total marks (Part III)	450
Grand Total	1350

* In order to qualify in English, a candidate will be required to score a minimum of 40% marks. But marks obtained in Paper Q 1 (English, qualifying) shall not be counted for determining the division of over all result.

Note : 1

(i) The students should be given intensive training in the understanding and applications of the concepts. They should also be trained for solving a variety of problems rather than in reproduction of factual information from books and lecture notes. Problem solving questions (not only objective and true-false) related to numerical, structural, synthetic, mechanistic and conceptual type should be given due emphasis in the examination.

(ii) The students should be encouraged to develop initiative and self-reliance through regular home/library assignments.

(iii) Only the SI units and the IUPAC conventions should be followed throughout the course.

(iv) The students can use calculators in theory and practical examinations. The calculators should not be provided by the University and the same should not be shared during examinations. However, University can provide log tables in examinations, if asked for.

(v) Name reactions in Organic Chemistry are to be dealt with as relevent to the context. Discussions of organic reactions should deal with their reaction mechanism.

(vi) Semi-micro level procedures should be used in the laboratory exercises.

(vii) Normality based calculations should be avoided, and instead 'one electron' equations should be used.

(viii) Use of carcinogenic chemicals and highly toxic chemicals should be avoided as far as possible.

(ix) All the theory papers will have 3 periods/week except for papers on Mathematics and Environmental chemistry which will have 4 periods/week.

(x) The number of periods for practicals in chemistry will be three.

DETAILED COURSES OF READING B.Sc. (Hons.) CHEMISTRY

PART I : (FIRST YEAR)

Paper : I **INORGANIC CHEMISTRY - 1** **M. Marks : 50**

Atomic Structure : Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics : de Broglie matter wave, Heisenberg's uncertainity principle and its significance, Schrodinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normal and orthogonal wave functions. Sign of ware functions. Radial and angular wave functions. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Contour boundary and probability diagrams.

Pauli's exclusion principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, variation of orbital energy with atomic number.

Periodicity of Elements : s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements.

(a) Effective nuclear charge, shielding or screening effect, Slater rules variation of effective nuclear charge in periodic table.

(b) Atomic radii (van der Waals)

(c) Ionic and crystal radii, (Bragg- Ζlater, Pauling)

(d) Covalent radii (octahedral and tetrahedral)

(e) Ionization energy, successive ionization energies and factors affecting ionization energy.

(f) Electron affinity.

(g) Electronegativity, Pauling's/Mulliken's/Allred Rachow's/and Mulliken-Jaffe's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity, electroneutrality principle. Sanderson's electron density ratio.

Chemical Bonding

(i) *Ionic bond :* General characteristics, types of ions, size effects, radius ratio rule and their limitations. Packing of ions in crystals. Born - Lande equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its aplications, Solvation energy.

(ii) *Covalent bond :* Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2,O_2,C_2, B_2, F_2, CO, NO and their ions; HCl, BeF_2, CO_2, (Idea of s-p mixing and orbital interacion to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach), bent bond approach and bond lengths.

Covalent character in ionic compounds, polarizing power and polarizability. Fajans rules and consequences of polarization.

Ionic character in covalent compounds : Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

(iii) *Metallic Bond :* Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

(iv) Weak Chemical forces : Vander Waals forces, Ion-dipole forces, Dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical forces, melting and boiling points, solubility energetics of dissolution process.

(v) *Acids and Bases :* Bronsted - Lowry concept of acid - base reaction, solvated proton, relative strength of acids, mechanism of proton transfer, amphoterism, types of acid-base reactions, levelling solvents, Lux-food concept, Lewis acid-base concept, Classification of Lewis acids (Electrophilic and Nucleophilic displacements). Usnovich concept, Hard and Soft Acids and Bases (H.S.A.B.) Application of H.S.A.B. principle.

Paper : II **ORGANIC CHEMISTRY-1** **M. Marks : 50**

Development and scope of organic chemistry. Natural sources of organic compounds (Petroleum and coaltar). Methods of isolation and purification (with emphasis on chromatography).

Criteria of purity. The following topics are to be taken up, including basic stereochemical concepts at appropriate places. Structure, shape and reactivity of organic molecules : Hybridization and types of bonds. Atomic and molecular orbitals. Shape of simple organic molecules. Polarity of bonds. Bond length. Bond strength and Bond energy and Dissociation energy. Hydrogen bond. Dipole moment. Electronic displacements : inductive, electromeric, hyperconjugative and resonance effects. Characteristics of ionic and homolytic reactions . Nucleophiles and

electrophiles. Shape, formation and stability of carbocations, carbanions and free radicals. Arrhenius, Lowry-Bronsted and Lewis concepts of acids and bases. Effects of structure on : pK values of acids and bases.

Alkanes : Nomenclature and classes of hydrocarbons. Preparation and reactions of alkanes (with emphasis on the mechanism of halogenation, relative reactivities of alkanes towards halogenation, transtition state for halogenation, energy of activation, energy changes during progress of reaction, relative reactivity of halogens towards alkanes, reactivity and selectivity). Concepts of chirality, configuration and conformation, torsional strain, vander Waals repulsions. Newman, Sawhorse and Fischer representations.

Cycloalkanes : Structure and their shape , Baeyer's strain theory. Orbital picture of angle strain. Stability and conformation of cycloalkanes with special reference to cyclohexane.

Alkenes : Nomenclature, preparation with special reference to elimination reaction and different types of addition reaction. isomerism (cis-trans) of alkenes, Heat of hydrogenation and stability of isomeric alkenes. Markownikoff and anti Markownikoff additions, alkenes, ozonolysis, electrophilic and free radical additions, cleavage, hydroboration, oxidation. Resonance, stability and orbital picture of allyl radicals and cations, hyperconjugation.

Resonance effect and role of unshared pairs. Nucleophilic substitution in allylic and vinylic substrates. Polymerisation.

Alkadrenes : Exemplified with 1, 3 butadiene and isoprene, methods of preparation and reactions, stability of conjugated dienes, ease of formation, electrophilic addition to conjugated dienes, 1, 4-addition, 1, 2 versus 1, 4 addition, free radical addition to conjugated dienes.

Alkynes : Structure, shape nomenclature, preparation and reactions including the acidity of alkynes, metal acetylides.

Aromatic hydcarbons : Structure and stability of benzene ring, Huckel rule including aromatic character, nomenclature of benzene derivatives, mechanism of electrophilic substitution, effect of substituents on orientations, theories of reactivity and orientation, preparation and reactions of alkenyl and alkyl benzenes, stability of benzyl radical and cation.

Petroleum : Origin, fractionation of crude petroleum to aliphatic, napthene and aromatic fractions, cracking, reforming and aromatisation, synthetic fuels, octane and cetane numbers, antiknock additives. Petrochemicals exemplified by synthesis of raw materials for polymers, aromatic compounds, detergents and pharmaceuticals.

Alkyl halides : Classification, nomenclature, preparation and reactions of alkyl halides, nucleophilic aliphatic substitution mechanisms, steric hindrance and effect of solvent. SN^1 and SN^2 reactions versus elimination (E^1 and E^2) reaction. Organometallic compounds of Magnesium, Lithium and their importance in synthesis.

Aryl halides : Structure, preparation and reactions. Nucleophilic aromatic substitution and benzyne as reaction intermediate.

Alcohols : Classification, nomenclature and preparation with special reference to hydrocorboration and oxymercuration. Grignard synthesis of alcohols. Reactions of alcohols, neighbouring group effects, alcohols as acids and bases, oxidation of alcohols, conversions to and from alcohols, Haloform reactions, glycols and their reactions with lead tetra-acetate and periodic acid, Pinacol-Pinacolone rearrangement.

Phenols : Structure, preparation, physical properties, and reaction of phenols, acidity of phenols, ring substitutions, Fries rearrangement, Kolbe's reaction, Reimer-Tiemann reaction.

Paper : III **PHYSICAL CHEMISTRY-I** **M. Marks : 50**

Gaseous state :

Kinetic molecular model of a gas; collision frequency, collision diameter, mean free path, and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; Barometric distribution and its use in the determination of Avogadro's number, Maxwell distribution of velocities and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

Behaviour of real gases : Deviations from ideal gas behaviour, compressibility factor, Z, van der Waals equation of state, its derivation and application in explaining real gas behaviour, virial equations of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

Intermolecular forces : Dipole moment and molecular polarisability, dipole-dipole, dipole-induced dipole, induced dipole-induced dipole, interactions; electrical origin of nonideal behaviour.

Liquid State :

Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity; qualitative discussion of structure of water.

Chemical Thermodynamics :

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.

First law : Concept of heat, q, work, w, internal energy, U and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Thermochemistry : Heats of reactions : standard states; enthalpy of formation of molecules and ions and enthalpy of combustion; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchoff's equation) and pressure on enthalpy of reactions.

Second Law : Concept of entropy, thermodynamic scale of temperature; statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Third Law : Statement of third law, concept of residual entropy; calculation of absolute entropy of molecules.

Gibbs and Helmholtz energy; variation of S,G, A with T, V, P; relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

Paper : IV **MATHEMATICS - I** **M. Marks : 75**

Statement of Leibnitz's theorem (nth derivative of xy, x^2y, x exp (x), $x^2\exp(x)$, $x\log(x)$).

Rolle's theorem, geometrical interpretation. Lagrange's theorem and its geometrical interpretation. Taylor's mean value theorem. Taylor's and Maclaurin's series. Expansions of exp(x), sin(x), cos(x), log (1+x) Indeteriminate forms, maxima and minima, monotone functions and inequalities, tangent and normals. Partial differentiation, curvature, asymptotes, curve tracing. Rational functions. Integration of rational and some simple irrational functions. Properties of definite integrals, simple reduction

formulae. Evaluation of areas and lengths of curves in the plane, centre of gravity and moment of inertia.

Differential equations of first order, linear equations with constant coefficients, linear homogeneous equations upto second order. Standard forms of pair of straight lines, circle, parabola, ellipse and hyperbola (polar and cartesian form), tracing of conics (simple examples only).

Three dimensional geometry (planes, lines, spheres). Complex numbers, De Moivres theorem. Relation between roots and coefficients of cubic equations, symmetric functions of the roots.

Paper : V **PHYSICS - 1** **M. Marks : 50**

Mathematical Physics : Scalar and Vector products, polar and axial vectors, triple and quadruple products.

Vector calculus : Scalar and vector fields, differentiation of a vector, gradient, divergence, curl and Δ operations and their meaning; idea of line, surface and volume integrals; Gauss and Stokes theorems.

CLASSICAL MECHANICS :

(a) Particle dynamics : Newton's laws of motion, conservation of linear momentum, centre of mass, conservative forces, work energy theorem, particle collision.

(b) Rotational kinematics and dynamics : Rotational motion, forces and pseudo forces, torque and angular momentum, kinetic energy of rotation, rigid body rotation dynamics, moment of inertia, conservation of angular momentum, comparison of linear and angular momentum, motion of a top.

Oscillations : Linearity and superposition principle, free oscillation with one and two degrees of freedom, simple pendulum, combination of two simple harmonic motions.

Lissajous figures, free and damped vibrations, forced vibrations and resonance, Q factor. Wave equation, travelling and standing waves, superposition of waves, phase and group velocity.

Wave Optics : Interference, division of amplitudes, divison of wave fronts, Young's double slit, Fresnel's biprism, interference in thin films and wedge shaped films.

Fresnel diffraction : Divison of wave fronts into half period zones, rectilinear propagation of light, zone plate, diffraction at a stright edge and a slit.

Fraunhoffer diffraction : Diffraction at a single slit and a circular aperture, diffraction at a double slit, plane transmission grating, resolving power of a telescope and a microscope, resolving and dispersive power of a plane diffraction grating.

Polarisation : Polarisation by reflection and refraction, Brewster's law, double refraction, nicol prism, quarter and half wave plates, production and analysis of circularly and elliptically polarised light.

Paper : VI (Option a) BIOLOGY FOR CHEMISTS M. Marks : 50

Origin and early history of life : Origin of organic molecules, nature of life processes, origin of prokaryotes, autotrophes, and Eukaryotes.

Molecular basis of living organisms : Building blocks of organisms, energy storing molecules, amino acids, proteins, nucleic acids, transcription, translation.

Techniques of study : Microscopy, chemistry of fixation and staining. Tissue culture methods. Hybridoma, Recombinant DNA and Polymerase Chain Reaction (PCR) methods. Cell fractionation. Structure and function of cellular constituents : Cell wall, plasma membrane, protoplasm and its colloidal nature, chloroplast, mitochondria, endoplastic reticulum, ribosomes, lysosomes, Golgi apparatus, centrioles, based granules. Nucleus, chromosome and chromosome basis of sex determination, celia, flagellium and microtubules.

Cell Cycle and its regulation : Cellular excitability, cellular motility, cellular secretion, cellular immunity, cellular aging and cell death, cellular respiration, cell permeability and endocytosis. Nucleo cytoplasmic interactions, role of cell surface and microtubes. Mitosis and meiosis and their significance.

Micro organisms : A general account of the viruses, bacteria and protozoans, with special reference to metabolism and genetic recombinations.

Diversity of plants : Plant life cycle (alternation of generation). Vascular plants and their conducting system. Life cycles of (i) the fern, (ii) the pine and (iii) flowering plant.

Diversity of animals : General classification of nonchordates and chordates.

Types of cells and their organization and function in tissues, muscle, epithelial, skeletal, bone, adipose and blood, and immune cells.

Organs and their functions : liver, kidney, heart, lung, brain, pancreas etc.

Paper : VI (Option b) ENVIRONMENTAL CHEMISTRY M. Marks : 75

Environment and its segments, Ecosystems. Biogeochemical cycles of carbon, nitrogen, phosphorus and sulphur.

Air Pollution : Major regions of the atmosphere. Chemical and photo-chemical reactions in atmosphere. Pollution of air by oxides of carbon, nitrogen and sulphur, hydrocarbons and particulates. Sources of air Pollutants : Chemical in dustry (metallurgical, non-metallurgical, non-metallic mineral, petroleum, and mining), food presessing industry, power plants and automobile exhaust.

Transfer of air pollutants from troposphere to earth and its interaction with materials (corrosion), physiological effects on vegetation and living organisms and interaction with hydrosphere.

Transfer of pollutants to the upper atmosphere, dissociation of chlorofluorohydrocarbons, formation and dissociation of ozone, catalytic role of Cl and NO; depletion of ozone layer and its effects. Photochemical smog. Green house effect.

Air pollution controls and their chemistry in reducing emission of SOx and NOx from various industries; significance of catalysts in air pollution control. Particulate control techniques. Control of automobile exhausts by modifications of internal combustion engines.

Techniques and procedure of measuring air pollutants. Air and Emission standards. Continuous monitoring instruments.

Soil and its pollution : Composition of soil, micro- and macro-nutrients, synthetic fertilizers, pollutants and wastes including pesticides, plastics and heavy metals. Waste treatment.

Water and its pollution : Hydrological cycle, water resources, aquatic ecosystems.

Water quality parameters - dissolved oxygen, bio-chemical oxygen demand, solids, hardness, metals, content of F^-, Cl^-, Cl_2, SO^2_4, NO_3, phosphates, alkalinity, acidity, micro-organisms. Drinking water. Water quality standards.

Sources and nature of water pollutants (stream, lake, ground and ocean) :- sewage, industrial effluents, soaps and detergents, pesticides, fertilizers, heavy metals, thermal pollution. Eutrophication, Preventive measures.

Techniques and procedures of measuring pollutants such as DO,BOD, COD, F^-, oils, phenolics, heavy metals such as As, Cd, Cr, Hg, Pb and Se and CN^-. Estimation of residual chlorine and chlorine demand.

Impact of pollutants on hydrological and ecosystems.

Waste water treatment-effluent standards : primary, secondary and tertiary treatment methods. Sewage treatment processes.

Water purification methods : Sedimentation, coagulation, filtration, disinfection, ion exchange process. Desalination.

Biochemical and biological changes due to toxic substances. Impact on enzymes. Biochemical effects of arsenic, cadmium, lead, mercury, Co, NOx, SO_2, ozone, CN^-, peroxyacetyl nitrate, cyanide, pesticides, insecticides such as DDT, MIC. Bhopal gas tragedy.

Energy and environment : Sources of energy : Coal, petroleum & natural gas, nuclear fission/fusion, solar energy, hydrogen, and miscellaneous like geothermal, tidal, hydel etc.

Nuclear pollution, disposal of nuclear wastes, nuclear disasters (Chernobyl disaster) and their management.

Noise and noise pollution.

Q. 1. English (qualifying) **M. Marks :100**

For detailed Course of qualifying English please see the syllabus For B.A. (Pass), B.Com. (Pass) and subsidiary qualifying English.

Lab. I **CHEMISTRY** **Max. Marks : 75**

INORGANIC CHEMISTRY

(a) Titrimetric Analysis

(i) Calibration and use of apparatus

(ii) Preparation of solutions of different Molarity/Normality of titrants.

(b) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in a mixture.

(ii) Estimation of carbonate and bicarbonate present together in a mixture.

(iii) Estimation of free alkali present in different soaps/detergents.

(c) Argentometry

Estimation of Cl^- (i) By Mohr's method, (ii) By Vohlard's method, (iii) By Fajan's method.

(d) Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardised $KMnO_4$ solution.

(ii) Estimation of oxalic acid and sodium oxalate in the given mixture.

(iii) Estimation of Fe (II) with $K_2Cr_2O_7$ using internal (Diphenylamine, anthranilic acid) and external indicator.

ORGANIC CHEMISTRY :

1. (a) Calibration of mercury thermometer.

(b) Determination of melting points and mixed melting points.

(c) Determination of boiling points of organic liquids.

(d) Detection of extra elements (N, Cl, Br, I, S.).

2. **Purification of organic compounds :**

(a) Recrystallisation : Acetanilide from hot water, naphthalene from alcohol, benzoic acid from hot water or ethanol. Use of animal charcoal in crystallisation of impure compounds.

(b) Distillation of aniline using air condenser, distillation of acetone using water condenser.

(c) Chromatography : Separation of (i) Monosaccharides

(ii) Amino acids by paper chromatography ; separation of ortho and para-nitrophenols by column and thin layer chromatography (for demonstration only).

3. **One stage preparation :**

(a) Sublimation of phthalic acid to phthalic anhydride.

(b) Benzoylation : aniline.

(c) Acetylation : aniline, salicylic acid.

(d) Bromination : aniline.

PHYSICAL CHEMISTRY :

1. Determination of heat capacity of a calorimeter for different volumes, from enthalpy data of a known system.

2. Determination of enthalpy of neutralisation of hydrochloric acid with sodium hydroxide.

3. Determinaion of enthalpy of neutralisation of acetic acid with sodium hydroxide. Calculation of the enthalpy of ionisation of acetic acid using data of experiments (1) and (2).

4. Determination of integral enthalpy (endothermic and exothermic) solution of salts.

5. Determination of enthalpy of hydration of $CuSO_4$.

6. Verification of Hess's law by utilising the enthalpy of neutralisation of (i) HCl (aq), (ii) Na OH (s) + HCl (aq), and (iii) enthalpy of solution of Na OH (s) in water.

7. Study of solubility of benzoic acid in water and determination o f Δ H.

8. Determination of basicity/acidity of a polybasic acid/polyacidic base.

9. Determination of enthalpy of following reaction.
   ($CO_3^{2-} + H_2O \rightarrow HCO_3^- + OH^-$)

10. Surface tension and viscositv measurement :

    (i) Study of surface tension of pure liquids and binary mixtures.

    (ii) Variation of surface tension of detergent solutions with cencentration.

    (iii) Variation of viscocity of a liquid with temperature.

    Any other experiments carried out in the class.

Lab. II **PHYSICS** **M. Marks : 25**

Each student is expected to do at least 3 experiments each from Group A and Group B.

Group A experiments :

A-1. Determination of spring constant of a spring by (i) static and (ii) dynamic methods.

A-2. Study of damped harmonic oscillator-Q factor.

A-3. Determination of temperature coefficient of resistance using platinum resistance thermometer.

A-4. Study of thermal couple calibration and inversion temperature.

A-5. LCR-Study of resonance, Q-factor.

A-6. Kators' Pendulum/Bar Pendulum.

Group B Experiments.

B-1. Determination of wavelength of light by Fresnel's biprism.

B-2. Determination of wavelength of sodium light by Newton's rearrangement.

B-3. Determination of refractive index of flint glass using a spectrometer.

B-4. Determination of dispersive power of a glass prism using Cauchy's constant. Determine the resolving power of a prism also.

B-5. Determination of wavelength of sodium light using a plane transmission grating and the resolving power of a differaction grating.

B-6 Determination of specific rotation of cane sugar solution using a polarimeter.

Lab. III **BIOLOGY** **M. Marks : 25**

Microscopic examination of various cell types (Permanent preparations from animals and plants). Paraffin embedding of plant tissues, staining of DNA, RNA, proteins, lipids and carbohydrates.

Analysis of E.M. photographs for identification of cellular organelles such as mitochondria, Golgi complex, Endoplasmic reticulum etc.

Preparation of blood smear, staining, and identification of cell types, differential cell count; total blood count; haemoglobin content.

Mitosis (Using onion root tip.)

Meiosis (flower buds/Grasshopper testes.)

Polytene chromosome-from Drosophila/Chironomus larva.

Staining of gram positive and gram negative bacteria, morphology. Important fungi including yeast and Neurosporacrassa, structure and reproduction.

Study of :

(a) one algae from each class
(b) a slime mould
(c) one member each from lichens, bryophytes, pteridophytes, gymnosperma.

Flowering plants-basic parts, their form and structure (stem, root, leaf, flower, fruit, seed etc.)

Musuem study of different animal types.

Extraction of chloroplast and its identification by T.L.C. Growth curves of yeast/E. Coli and determination of generation time.

Abnormal constituents of urine : albumin, haemoglobin, bile pigment, glucose.

Colour reaction (qualitative) for DNA and RNA from animal tissues.

PART II (SECOND YEAR)

Paper : VII **INORGANIC CHEMISTRY - 2** **M. Marks : 50**

General principles of Metallurgy : Chief modes of occurrence of metals based on standard electrode potential, principles of methods used for concentration of ores, calcination, roasting and smelting. Role of carbon and other reducing agents : eletrolytic reduction, hydrometallurgy, Ellingham diagrams, Methods of refining and purification : Electrolytic, chromatographic, ion exchange, solvent extraction, oxidative refining, parting process, Zone-refining, Kroll's Process, van-Arkel de Boer method, Mond's process.

Chemistry of s and p block elements : General group trends, electronic configuration, atomic and ionic radii, ionization potential, electron affinity, electronegativity, oxidation states (relative stability and stereochemistry), aqueous chemistry, diagonal relationship and anamalous behaviour of first member of each group. Inert pair effect, allotropy and catenation. Complex formation tendency of s & p block elements (No details).

Hydrides and their classification (ionic, covalent and interstitial. Basic beryllium acetate and nitrate.

A study of the following compounds with emphasis on structure, bonding, preparation, properties and uses.

Boric Acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds,silanes, oxides and oxoacids of nitrogen. Phosphorus and chlorine. Peroxy acids of sulphur, thionic acid, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

Noble gases : Occurrence & uses, rationalization of inertness of noble gases and its failings; Clathrates, preparation and properties of XeF_2 and XeF_4, nature of bonding in noble gas compounds (Valance bond treatment and MO treatment for XeF_2) Molecular shapes of noble gas compounds (VSEPR theory).

Principles involved in II yr inorganic practical course.

Paper : VIII **ORGANIC CHEMISTRY - 2** **M. Marks : 50**

Ethers : aliphatic and aromatic and epoxides and their important reactions.

Aldehydes and ketones (aliphatic and aromatic) : Structure, nomenclature, preparation and reactions : oxidation, reduction, cyanohydrins, hydrazones, semicarbazones and acetal formation, Aldol condensation, Cannizzaro reaction, Claisen condensation, Reformatsky reaction, Perkin reaction, Benzoin condensation, Benzil-benzilic acid rearrangement, Wittig reaction, Beckmann rearrangement.

Carboxylic acids and their functional derivatives (aliphatic and aromatic) : Structure, nomenclature, sources and preparation of carboxylic acids, physical properties and reactions, acidity and effect of substituents, conversions into acid chlorides and alcohols, halogen substituted aliphatic acids. Preparation and reactions of acid chlorides, anhydrides, amides and esters; role of carbonyl group in nucleophilic acyl substitution, acidic and alkaline hydrolysis of esters, **Nitrocompounds :** Nitroalkanes, nitrites, isonitriles, aromatic nitroso compounds. **Active Methylene Compounds :** Preparation, typical reactions and synthetic uses of acetoacetic ester and malonic ester, keto- enol tautomerism with different examples.

Amines (Aliphatic and Aromatic) : Classification, nomenclature and preparation of amines, Hofmann bromamide degradation with mechanism, basicity of amines-effect of substituents and solvents, exhaustive methylation, Hofmann versus saytzeff elimination reactions of amines, diazonium salts : preparation and synthetic uses, Sandmeyer reaction, Mannich reaction and Hinsberg test.

Preparation, Typical Reactions, Structure and uses of the following Classes of Compounds : Dibasic acids, hydroxy acids : lactic, malic, tartaric and citric acids, unsaturated alcohols, aldehydes, ketones and acids, maleic and fumaric acids, addition reactions of unsaturated carbonyl compounds. Urea, urethanes.

Stereochemistry : Optical activity and optical isomerism, specific and molar rotation. Enantiomerism, chirality, elements of symmetry and simple symmetry operations. Configurational nomenclature. D and L designation Absolute configuration, Diastereomers, meso structures, Geometrical isomerism and methods of determining the geometry and identification, cyclohexane : boat and chair forms and their stability. E and Z designation of geometrical isomers. Woodward-Hoffman rules and cycloaddition with reference to Diels-Alder reaction.

Sulphur contalning compounds : Preparation and reaction of thiols, thioethers and sulphonic acids.

Paper : IX **PHYSICAL CHEMISTRY - 2** **M. Marks : 50**

Chemical Tehermodynamics

Systems of variable composition :

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ide mixtures, change in thermodynamic functions in mixing of ideal gases; criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concepts of fugacity, activity and activity coefficient. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration, Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase. Multistage equilibria in polyelectrolyte systems; dissociation constants of mono-, di-and tri-protic acids (exact treatment); hydrolysis and hydrolysis contants.

Phase equilibria

Concept of phase, components, and degree of freedom, derviation of Phase rule for non-reactive and reactive systems; Clausius-Clayperon equation and its application to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems.

Solutions : Dilute solution, lowering of vapour pressure, Raoult's and Henry's Laws. Colligative properties : (i) elevation of boiling point, (ii) depression of freezing point, (iii) osmotic pressure.

Binary solutions : Duhem-Margules equation and its applications to fractional distillation of binary micible liquids, azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation; Nernst distribution law, its derivation and applications.

Phase diagram for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting point, solid solution.

Three component systems, water-chloroform-acetic acid system, triangular plots.

Macromolecules : Distrubution in chain lengths of synthetic linear macromolecules, average molar masses; determination of average molar masses by methods based on osmotic pressure, sedimentation, viscosity and gel permeation methods (qualitative description and discussion of methods).

Conductance :

Arrhenius theory of electrolytic dissociation, strong and weak electrolytes, Debye-Huckel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rule.

Ionic velocities, mobilities and their determination, transference numbers and their relation to ionic mobilities, applications of conductance measurement : (i) degree of dissociation, (ii) ionic product of water, (iii) solubility product, (iv) conductom etric titrations. and (v) hydrolysis constant.

Paper : X **MATHEMATICS - II** **M. Marks : 75**

Algebra of matrices, definitions and examples of symmetric, skew symmetric, orthagonal and unitary matrices. Rank of matrix, invariance of rank under row and column transformations (proofs not to be discussed), eigen values, eigen vectors.

Cayley Hamilton theorem (with proof), linear equations with three unknown quantities.

Convergence and divergence of sequences, monotonic sequences. Comparision test, ratio test, root test and Raabe's test for convergence and divergnce for positive term series. Leibnitz test for alternating series.

Double and triple integrals. Beta and gamma functions.

Statistics :

Probablity, theorems on probablity (with proofs). Mathematical expectation, Binomial, Poisson and normal distributions, correlations and regression, least square method. Fitting of straight lines and parabola, sampling : large sample tests, t-test, f-test, x^{2} test.

Paper : XI **PHYSICS - 2** **M. Marks : 50**

Electrostatics : Electric field, potential due to a charge distribution and due to a dipole, electrical potential energy, flux, Gauss's law, electric field in a dielectric, polarisation, energy stored in electric field.

Magnetism : Magnetic field due to a current carrying conductor. Biot Savart law, magnetic force on a current, Lorentz force, electromagnetic induction, Lenz's law, magnetic properties of matter, para-. dia-and ferro-magnetism, spinning of a magnetic dipole in an external magnetic field.

Fundamental laws of electromagnetism : Modification of Ampere's law, equation of continuity and displacement current, Maxwell's equations, wave equation and its plane wave solution, nature of electromagnetic waves transversality and polarisation, propagation of electromagetic plane waves in dielectric media.

Electronics : Half wave, full wave and bridge rectifiers, ripple Factor, rectification efficiency, filters (series in inductor, shunt capacitor, LC and pi sections), voltage regulations, load regulation, Zener diode as voltage regulator. Characterestic curves of bipolar transistors, static and

dynamic load line, biasing (fixed and self) of transistor circuit, thermal instability of bias, the black box idea of CE, CB and CC transistor circuits as two port network, small signal active out put, hybrid model of a CE transister circuit, analysis of a small signal amplifier : its voltage and current gains, input and output impedance, feedback in amplifiers, advantages of negative feedback and positive feedback, Barkhausen's criterion for self-sustaining oscillations, LC and phase shift oscillators.

Digital electronics : Number systems (Binary, BCD, Octal and Hexadecimal) 1's and 2's complements. Logic gates, AND, OR, NAND, NOR XOR and NXOR. Boolean Algebra (Boolean laws and simple expressions). binary adders; Half adder, Half subtractor, full adder and subtractor.

Paper : XII (Option A) **M. Marks : 75**

COMPUTERS AND APPLICATIONS TO CHEMISTRY

Note 1. In this course, teaching of theory is coupled with training of use of computers.

Note 2. The examination will consist of a Theory Part (1 hr., 25 marks) and a Practical part (3 hrs., 50 Marks. 15 marks reserved for Lab. Record and 15 marks for viva-voce)

Basic components of a computer system, their function and inter-relations; types of computer systems; binary number system and arithmetic; internal data representation; integer and floating point numbers.

Data storage; Semiconductor main memory; magnetic tapes and disks. Read/write operations; floppy disk. Input/Output devices : tape/disk/ diskettes; VDU.

Problem solving and BASIC programming : Algorithms and flow charts; program definition and development concepts; structured programming.

Elements of BASIC language : Variables and constants; arithmetic expressions and assignment statements; mathematical functions; Input/ Output statements; control statements; For/NEXT loop; subprograms and functions, arrays and dimensioned variables, string variables and commands for handling strings; Graphics.

Use of Spread Sheets, statistical packages in solving problems in Chemistry.

The laboratory exercises should cover

(i) Solution of quadratic equations (ii) factorical values of a number, (iii) matrix manipulations, (vi) binary search method, (v) standard deviations measure of central tendency, (vi) least-square fitting, (vii) curve fitting, (viii) plotting linear and exponential graphs, (ix) regression analysis and (x) handling polynomials.

The laboratory exercises should illustrate the use of computer for solving problems in chemistry. Some examples :

(a) Plotting the Maxwell distribution curve for the speed of gas molecules (b) Pressure-volume curves for a van der Waals gas, (c) Molar extinction coefficient from absorbance data. (d) Rate constant from concentration-time data. (f) handling data from phase equilibria studies.

Paper : XII (Option B) **M. Marks : 75**

ENTREPRENEURSHIP AND SMALL BUSINESS

Concept of entrepreneurship, entrpreneurial competencies, Small business as seed-bed of entrepreneurship. Small business promotion and development policies, national and state level financial and non-financial institutions.

Small business project identification, analysis of environmental opportunities, market survey, estimation of demand and supply.

Small business project formulation and implementation. Preparation of project report (determining project size, form of organisation, site

selection, appropriate technology, estimating cost,break-even analysis and tax consideration), Assessment of project feasibility (managerial, financial marketing and technical). Steps in setting up of a business venture. Basic start-up problems.

Financing of small business : fixed and working capital requirements, estimation and sources. Concepts of shares, debentures, leasing, hire purchase, venture capital, trade credit and bank credit.

Issues in small business marketing : marketing information, market segmentation, concept of product, pricing, advertising and salesmanship and channels of distribution.

Maintenance of account books for small business. Books of original entry and ledgers. Preparation of trial balance and final accounts. Preparation of accounts from incomplete records.

Growth of small business : expansion, diversification and merger. Problems in delegation and succession at growth stages.

Lab. IV **CHEMISTRY** **M. Marks :75**

INORGANIC CHEMISTRY

Inorganic Preparations

(i) Tetraammine copper (II) sulphate, $[Cu(NH_3)_4]\,SO_4.\,H_2O$

(ii) Potassium trisoxalatochromate (III), $K_3[Cr(C_2O_4)_3]$

(iii) Sodium peroxoborate

(iv) Cis and trans $K\,[Cr(C_2O_4)_2\,(H_2O)_2]$
Potassium dioxalatodiaquachromate (III)

(v) Preparation of Manganese (III) phosphate, $MnPO_4.\,H_2O$

(vi) Preparation of Aluminium Potassium sulphate
$KAl\,(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.

Iodo/Iodimetric Titrations

(i) Estimation of Cu (II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically)

(ii) Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically

(iii) Estimation of available chlorine in bleaching powder iodomertically.

Complexometric Titrations :

(i) Complexometric estimation of (i) Mg^{2+} (ii) Zn^{2+} using EDTA

(ii) Estimation of total hardness of water samples.

(iii) Estimation of Ca^{2+} in solution by (substitution method) using Erio-T as indicator.

(iv) Estimation of Ca/Mg in drugs and in Biological samples.

ORGANIC CHEMISTRY

1. **Reduction :** Preparation of aniline from nitrobenzene, using Fe/Hcl, m-nitroaniline from m-dinitrobenzene using Na_2S+S
2. Aniline to acetanilide and then
3. to p-bromoacetanilide.
4. **Hydrolysis :** p-bromoaniline from p-bromoacetanilide; benzoic acid from ethylbenzoate and benzamide :
5. **Diazotisation/Coupling :** preparation of methyl orange and methyl red.
6. Preparation of 2,4-DN P, Oximes, Semicarbazones.

7. Hydroquinone to p-benzoquinone and then acetylation. (Thiele's acetylation).

8. Preparation of neroline from β-naphthol by $(CH_3)_2 SO_4$ / Na OH methylation.

9. Benzyl chloride to S-benzylisothiuronium chloride.

10. **Nitration :** nitrobenzene to m-dinitrobenzene.

11. **Oxidation :** benzaldehyde to benzoic acid using $KMnO_4/Na_2 CO_3$

PHYSICAL CHEMISTRY

1. Determination of partial molar volumes.

   (a) Sodium chloride-water system.

   (b) Carbon tetrachloride-benzene system

2. Determination of molar mass of phenyl acetic acid by depression in freezing point method using benzene as the solvent.

3. Determination of critical solution temperature of the following systems : (i) Phenol-water (ii) triethyl amine-water (iii) o-methoxy phenol-glycerol, and study the effect of impurities.

4. Study the equilibrium of at least one of the following reactions by distribution method :

   (i) $I_2 (aq) + I^- (aq) \rightarrow I^-_3 (aq)$

   (ii) $Cu^{2+} (aq) + nNH_3 \rightarrow Cu (NH_3)_n 2+$

5. To study changes in conductance in the following systems

   (a) strong acid - strong base

   (b) weak acid - strong base, and

   (c) mixture of strong acid and weak acid strong base.

6. Study the variation of viscosity of polyvinyl alcohol/polyvinyl pyrrolidone as a function of concentration and calculate average mass number (Mn or Mw).

7. **Phase equilibria :** (i) construction of the phase diagram of (a) simple eutectic and (ii) congruently melting systems, using cooling curves and ignition tube methods.

(ii) construction of liquid-vapour phase diagram.

Any other experiment carried out in class.

Lab V **PHYSICS** **M. Marks : 25**

1. *Study of a ballistic galvanometer :* resistance, current sensitivity charge sensitivity and critical damping resistance of the galvanometer.

2. Determination of high resistance by leakage method.

3. Determination of mutul inductance by ballistic galvanometer.

4. Operation and measurments by Cathode Ray Oscilloscope (C.R.O.) Calibration for DC and AC Voltages, frequency and phase measurements of a signal.

5. Study of transistor characterestics (CB, CE,CC configurations).

6. Study of power supply (rectification factor, voltage and load regulation for C, L, CL and pi filters).

7. Study of basic RC coupled amplifier (frequency response and band width)

8. Study of Colpitts oscillator.

9. Self inductance measurement by owen's bridge.

10. Measurement of magnetic field by search coil.

11. To verify experimentally OR,NAD, NOT, NOR, NAND Gates.

12. Study of Half Adder/Subtractor.

PAPER III (THIRD YEAR)

Paper : XIII INORGANIC CHEMISTRY - 3 Max. Marks : 50

Transition elements : General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Ebsworth diagrames). Difference Between the first, second and third transition series.

Chemistry of Ti, V. Cr, Mn, Fe and Co in various oxidation states (excluding their metallurgy).

Lanthanides and actinides : electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

Coordination Chemistry :

Bonding theories : Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo, Δt), CF SE in weak and strong fields, pairing energies, factors effecting the magnitude of 10 Dq (Δo. Δt). Octahedral Vs tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn Teller theorem, square planar coordination. Ligand field and MO Theories (Elementary idea only).

Isomerism in coordination compounds. IUPAC nomenclature of coordination compounds Stereochemistry of complexes with 4 and 6 coordination numbers. chelate effect, polynuclear complexes.

Reaction kinetics and mechanism :

The trans effect, theories of trans effect, kinetics of substitution reactions in square planar complexes. Thermodynamic and kinetic stability including factors affecting them. Labile and inert complexes.

Paper : XIV INORGANIC CHEMISTRY - 4 M. Marks : 50

(i) **Organometallic chemistry :** Definition and classification of organometallic compounds. Metal alkyls of 1, 2 and 13 group elements, Effective atomic number rule. Metal carbonyls : Synthesis, carbonylate anions, ferrocene and its reactions. Nitrosyls, complexes of olefins.

(ii) **Bioinorganic chemistry :** Metal ions present in biological systems : classification of elementts according to their action in biological system. Geochemical effect on the distribution of metals. sodium/K-pump. Biochemistry of Mg and Ca. Metalloanzyme oxaloacetate decarboxylase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions and reasons for toxicity, Use of chelating agents in medicine.

Iron and its application in bio-systems, Storage and transfer of Iron.

(iii) **Non-aqueous solvents :** A detailed study of reaction in liquid NH_3, SO_2 and comparison of these reactions with those occurring in water as solvent.

(iv) **Inorganic Polymers :** Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Phosphonitrilic halides, condensed phosphates, Borazines, phosphazenes.silicates & polysulphates.

(v) Theoretical principles and chemistry involved in qualitative analysis of mixture of cations and anions including interfering and insolubles.

Principles involved in gravimetry : Particle size, precipitation, coagulation, peptization, co-precipitation, digestion. Precipitation from homogeneous solution, common precipitants (e.g. hydroxides, sulphides and organic reagents). Filtration and washing of precipitates, drying and ignition of precipitates. requirements for gravimetric precipitations.

Paper : XV **ORGANIC CHEMISTRY - 3** **M. Marks : 50**

Carbohydrates : Occurrence, classification and general study of their properties, inter-relationship among monosaccharides. Constitution of glucose and fructose. Mutarotation. Determination of size of the ring. Configuration of the hydroxyl groups. Haworth projections, conformational structures. Structures of ribose, 2-deoxyribose, maltose, lactose and sucrose (excluding structure determination and synthesis). Elementray treatment of starch, cellulose and glycogen.

Amino Acids, Peptides and Proteins : Synthesis and properties of amino acids, Zwitterionic nature, pK values, isoelectric point and electrophoresis. Methods of synthesis of poly-peptides and their general properties.Descriptive study of proteins, their classification and biological importance. Secondary structure of proteins and helix.

Pyrimidines and Purine : Synthesis and reactions, Simple ureids : reactions and synthesis, Structure, synthesis and reactions of adenine, guanine, cytosine, uracil, thymine, uric acid, caffeine, barbituric acid. Elementary idea of nucleic acids.

Enzymes : Nomenclature, Coenzymes, difference between enzymes and coenzymes, Cofactors. Factors that influence enzyme action. Specificity and stereospecificity of enzymes mechanism of enzyme action enzyme inhibitors. Alcoholic fermentation, glycolysis, the Kreb's cycle.

Lipids : Biological functions and types of lipids, OILS AND FATS : occurrence in foods and compositions, Industrial oils of vegetable origin. common fatty acids present in fats and oils. Extraction, refining and hydrogenation of fats and oils . Identification of fats and oils. Physical and chemical properties : saponification value, acid value, and iodine number. flavour changes in oil and fats. Reversion and rancidity.

Terpenes : Essential oils : Occurrence, isolation, classification of terpenes, chemical composition. Isoprene rule, structure and synthesis of citral and dipentene. classical & non-classical carbonium ions.

Cleansing Agents : Mineral and fixed oils; toilet and washing soaps; preparation and uses. Synthetic detergents : Alkyl, aryl sulphonates, fatty alcohol sulphates, ethanolamine, nonionic detergents.

Paper : XVI **M. Marks : 50**

ORGANIC CHEMISTRY - 4

Spectroscopy : UV, IR and NMR spectroscopy and their applications in identification of organic compounds.

Polynuclear Hydrocarbons : Naphthalene, anthracene and phenanthrene : structure, synthesis and important derivatives, Carcinogenicity.

Heterocyclic Compounds : Synthesis, reactions, aromaticity, mechanism of substitution and important derivatives : furan, pyrrole, indole, thiophene, pyridine, quinoline and isoquinoline.

Pharmaceutical Compounds : Sulpha drugs-Sulphadiazine, analgesics : aspirin, phenacetin, paracetamol, antimalarials-chloroquine, An elementry treatment of antibiotics, a detailed study of chloramphenicol.

Dyes : Synthesis of azo dyes, diazo-coupling, mechanism of diazo coupling. Important groups. of azo dyes. Synthesis of some typical azo dyes : methyl orange, methyl red, congo red. Triphenyl methane dyes : malachite green, pararosaniline, rosaniline, crystal violet, methyl violet.

Phthalein dyes : phenolphthalein and fluorescein.

Copper phthalocyanine. Mordant and Vat dyes.

Structure and synthesis of alizarin and indigo.

Chemistry of dyeing, colour and constitution-Modern views.

Polymers : Introduction to synthetic polymers, types of polymers : isotactic, syndiotactic, atatic, thermoplastic and thermosetting polymers.

Polymerisation reactions : addition and condensation polymerisation. Mechanism of addition polymerisation reaction : free radical, cationic, anionic and Zeigler Natta Catalysed.

Vinyl polymers-methods of vinyl polymersation. PVC, polyvinyl acetate, poystyrene and teflon. Urea-formaldehyde and phenol-formaldehyde resins-Bakelite. Polyurethanes-foam formation. Synthetic fibres, polyamido fibres, nylon-6, 6, nylon-6, polyester and polyacrylic fibres. Natural and synthetic rubbers.

Alkaloids : Occurrence, importance, general structural features and properties. Hofmann's exhaustive methylation. Isolation, structure and synthesis of nicotine, atropine and cocaine.

Paper : XVII **PHYSICAL CHEMISTRY - 3** **M. Marks : 50**

Chemical kinetics :

Order of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions upto second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions upto first order only) :

(i) Opposing reactions, (ii) Parallel reactions, and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms), (iv) chain reactions.

Temperature dependence of reaction rates; catalysis, enzyme catalysis, Michaelis-Menten equation, acid-base catalysis, activation energy.

Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rate.

Photochemistry :

Laws of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching.

Electrochemical cells :

Electormotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants and (iii) pH-values, using hydrogen, quinone-hydroquinone, glass and SbO/ Sb_2O_3 electrodes. Concentration cells with and without transference, liquid junction potential; qualitative discussion of potentiometric titrations (acid-base, redox, preciptation) .

Surface Chemistry :

Physical adsorption, chemisorption, adsorption isotherms, nature of adsorbed state; catalytic activity at surfaces, mechanisms of catalysed reactions; catalytic processes like hydrogenation, 'cracking' etc. Micelles and their structure.

Paper : XVIII PHYSICAL CHEMISTRY - 4 M. Marks : 50

Atomic Structure :

Postulates of quantum mechanics, quantum mechanical operators, Schrodinger equation and its application to particle in a "box" (rigorous treatment) energy levels, wave functions, probability distribution functions, nodal properties, degeneracy; qualitative treatment of (i) rigid rotator, (ii) harmonic oscillator, (iii) hydrogen atom, (iv) electron spin and (v) multi-electron atoms.

Chemical Bonding :

Covalent bonding, statement of variation theorem, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+ and H_2 molecules, valence bond treatment of H_2 molecule, localised and non-localised molecular orbitals of homonuclear, heteronuclear diatomic and triatomic (BeH_2, H_2O, CO_2) molecules.

Electrical and magnetic properties :

Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Lorentz equation, measurement of dipole moment and molecular

poalrisability. Magnetic susceptibility, its measurement and molecular interpretation.

Molecular Structure :

Molecular Spectroscopy : Interactions of electromagnetic radiation with molecules and various types of spectra; Born-Openheimer approximation. Rotation spectroscopy : Rotational term (F), intensities of spectral lines, determination of bond length of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy : Vibrational terms (G), Classical equation of vibration, vibrational energies of diatomic molecules, zero point energy, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, concept of group frequencies. Vibration-rotation spectroscopy : diatomic vibrating rotator, P,Q,R branches.

Raman spectroscopy : Qualitative treatment of Rotational Raman effect; effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion principle.

Electronic spectroscopy : Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model. Nuclear Magnetic Resonance (NMR) spectroscopy : Principle of NMR, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of A-X type organic molecules.

Electron Spin Resonance (ESR) spectroscopy and its principle, hyperfine structure, ESR of simple radicals.

Structure of condensed phases : Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements, and symmetry operations, qualitative idea of point and space groups, seven crystal

systems and fourteen Bravais lattices; X-Ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl.

Lab VI **CHEMISTRY** **M. Marks : 150**

INORGANIC CHEMISTRY

Qualitative analysis : Using H_2S/PTC/Thioacetamide or any other reagent. Identification of cations and simple anions in a mixture of salts containing not more than six ions (Three cations - three anions) insoluble, interfering anions using semimicro scheme of analysis. If combination of cations or anions is given in the mixture, insoluble should be avoided. Spot tests should be carried out for final identifications wherever feasible.

Quantitative Analysis : The following quantitative estimations are to be carried out.

(i) Estimation of nickel (II) using Dimethylglyoxime as the precipitant.

(ii) Estimation of copper as CuSCN.

(iii) Estimation of Pb (II) in solution as $PbCrO_4$.

(iv) Estimation of iron as Fe_2O_3, by preciptating iron as $Fe(OH)_3$ through (i) Heterogenous and (ii) Homogenous media.

(v) Estimation of Mg (II) as magnesium pyrophosphate $Mg_2P_2O_7$

(vi) Estimation of Al (III) by precipitating with oxine and weighing as Al $(oxine)_3$ (aluminium oxiate).

ORGANIC CHEMISTRY

1. Systematic identification of organic compounds : monofunctional groups like carboxyl, hydroxyl, phenolic, aldehyde, ketone, ester 1^o, 2^o and 3^o amino, nitro, amido, and carbohydrates, hydrocarbons,

aromatic halogen compounds, thiourea.. Bifunctional compounds, e.g. nitroanilines, nitrophenols, hydroxybenzoic acids, hydroxy benzaldehydes, cinnamic acids).

2. Determination of saponification equivalent of castor oil.

3. Determination of percentage purity of glucose by titration with Fehling's solution.

4. Estimation of phenol and aniline by bromide-bromate method.

5. Estimation of urea by hypobromite method.

PHYSICAL CHEMISTRY

1. Study of adsorption of acetic acid by charcoal.

2. Study the kinetics of the following reactions.

   (i) Initial rate method : Iodide -persulphate reaction.

   (ii) Integrated rate method :

      (a) Acid hydrolysis of methylacetate with hydrochloric acid, volumetrically or conductometrically.

      (b) Iodide-persulphate reaction.

      (c) Saponification of ethylacetate.

   (iii) Gas evolution method :

   $$C_6H_5N_2C\ell + H_2O \rightarrow C_6H_5OH + HC\ell + N_2$$

   (iv) Study of kinetics of interaction of crystal violet with sodium hydroxide colorimetrically.

3. Preparation of saturated calomel electrode (SCE) or silver-silver chloride electrode and perform the following potentiometric titrations (at least two) :

(i) Strong acid with strong base, (ii) weak acid with strong base and (iii) dibasic acid with strong base.

4. Potentiometric titration of Mohr's salt with potassium dichromate.

5. EMF measurement of Clark or Daniel cell and its variation with temperature, and calculation of ΔG, ΔH, ΔS of the cell reaction.

6. Colorimetry

   (a) Verification of Lambert-Beer's law

   (b) Determination of pK (indicator) for phenolphthalien or methyl red.

   (c) Study the formation of a complex between ferric and thiocynate (or salicylate) ions.

7. Analysis of the given vibration rotation spectrum of HCl (g)

8. Indexing of given powder diffraction pattern of a cubic crystalline system.

Any other experiment carried out in the class.

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