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UNIVERSITY OF DELHI

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SCHEME OF EXAMINATION
AND
COURSES OF READING
FOR
B.Sc. (HONOURS) EXAMINATION IN CHEMISTRY

Part I Examination *1992*
Part II Examination *1993*
Part III Examination *1994*

No 9

Syllabi applicable for students seeking admission to the B.Sc. (Hons.) Chemistry Course in the academic year 1991-92

Price : Rs 3.00

B.Sc. (Honours) in Chemistry

SCHEME OF EXAMINATION

Part : I—Examination 1992

		Duration (Hours)	Max. Marks
Paper	I—Inorganic Chemistry	3	50
Paper	II—Organic Chemistry	3	50
Paper	III—Physical Chemistry	3	50
	Practical Test (2 Papers/2 days/ 5 hours each day)		75

Note : The Practical Test shall carry 75 marks, out of which 15 marks shall be reserved for the Laboratory Records and assessment by the class teachers of the day-to-day laboratory work of the candidates and 15 marks for the viva-voce examination.

Part : II—Examination 1993

		Duration (Hours)	Max. Marks
Paper	IV—Inorganic Chemistry	3	50
Paper	V—Organic Chemistry	3	50
Paper	VI—Physical Chemistry	3	50
	Practical test (2 Papers/2 days) (6 hours each day)		75

(i) *Inorganic Chemistry*
Practicals—15 Marks
Viva-Voce—5 Marks
Laboratory
Record —5 Marks

(ii) *Organic Chemistry*
Practicals —15 Marks
Viva-Voce— 5 Marks
Laboratory
Record — 5 Marks

(iii) *Physical Chemistry*
Practicals —15 Marks
Viva-Voce— 5 Marks
Laboratory
Record — 5 Marks

Part III— Examination . 1994

	Duration (Hours)	Max. Marks
Paper VII—Inorganic Chemistry—A	3	50
Paper VIII—Inorganic Chemistry –B	3	50
Paper IX—Organic Chemistry—A	3	50
Paper X—Organic Chemistry—B	3	50
Paper XI—Physical Chemistry—A	3	50
Paper XII—Physical Chemistry—B	3	50
Practical test (3 Papers/3 days) (6 hours each day)		150

(i) *Inorganic Chemistry*
Practicals —30 Marks
Viva-Voce —10 Marks
Laboratory
Record —10 Marks

(ii) *Organic Chemistry*
Practicals —30 Marks
Viva-Voce —10 Marks
Laboratory
Record —10 Marks

(iii) *Physical Chemistry*
Practicals —30 Marks

Viva-Voce – 10 Marks
Laboratory
Record —10 Marks

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

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

(iii) It is desirable to introduce the use of SI units gradually.

(iv) Name reactions in Organic Chemistry are to be dealt with as relevant to the context.

The Honours Examination for the Degree of Bachelor of Science shall include:

(1) A qualifying test in English at the end of the first year:

(i) Students who have not read English beyond class X in school will study the second year English 'B' course.

(ii) Students who have not read English even upto class X in school will study the above mentioned course, but they may, if so advised, also take the Remedial English course.

(iii) Students who read core English in classes XI and XII will study the second year English 'A' course.

(iv) Students who read Elective English in classes XI and XII will study the Second Year Elective English course.

Note: Composition exercises, where set, will include topics of interest to students in Science and Vocational course.

(2) A qualifying test in one of the following subjects (100-Marks) at the end of the second year— one Paper.

(a) Physical Sciences consisting of Physics or Chemistry/Mathematical Science including Statistics.

(b) Life Science consisting of Botany/Zoology and Anthropology.

(c) Earth Sciences comprising basically of Geological Science.

(d) Mathematical Sciences including Statistics and operational Research.

(e) Behavioural Sciences.

(f) History of Science and Scientific Method.

Subsidiary Subjects:

Two Examinations in each of two Subsidiary subjects; First examination at the end of first year and second examination at the end of the second year.

(a) Physics and

(b) Mathematics

DETAILED COURSES OF READINGS

B.Sc. (Honours) Examination, 1992

Paper I : *Inorganic Chemistry* *50 Marks*

Atomic structure : Historical development of the subject, Bohr's theory and its limitations.

Idea of de-Broglic matter waves, Heisenberg uncertainity Principle, Schrodinger wave equation, significance of wave functions and, ψ quantum numbers, normal and orthogonal wave functions, probability density pattern for hydrogen atom (qualitative idea) radical and angular wave functions. Sign of wave functions, shapes of s, p, d, f orbitals, idea of electron spin, four quantum numbers and their significance.

Multielectron systems : Pauli's exclusion principle, Hund's rule of maximum multiplicity, aufbau principle and its limitations; energy level diagrams.

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

(a) Effective nuclear charge, shielding or screening effect, Slater rules.

(b) Atomic radii, (van der Waals, Bragg-Slater atomic radii).

(c) Ionic Raddii and crystal radii.

(d) Covalent radii (Octahedral and tetrahedral).

(e) Ionization potential and electron affinity.

(f) Successive ionization potentials and factors influencing ionization potential.

(g) Electro-negativity (Pauling, Mulliken, Allred Rochow, Mulliken-Jaffa's electronegativity scales, variation of electronegativity with bond order, partial charge, hybridization; group electronegativity, electroneutrality principle, Sanderson electron density ratio.

Chemical Bonding

Ionic Bond : General Characteristics, type of ions, size effects, radius ratio, packing of ions in crystal, Lattice energy, Born equation (Calculation of energy in ion pair and ion pair square formation) Madelung constant, Born-Haber Cycle, Covalent character in Ionic compounds, Polarizing Power and Polarizability (Frjan's rule), Bond Moment and Dipole Moments, Percentage ionic character from Dipole Moments and Eleotronegativity difference.

Covalent Bond : General characteristics, coordinate covalent Bond, Valence bond approach, directional characteristics of covalent bond, Resonance and resonance energy, hybridization, multiple bonding, sigma and pi (Three electron bond) bonds, bond length, bond order, formal charge valence Shell electron pair repulsion (VSEPR) theory of directed valence, shapes of simple Inorganic molecules and ions containing lone pairs and bonds. Hydrogen bond (theories of hy-

drogen bonding. valence bond treatment), metallic bond (qualitative ideas of free electron, valence bond and bond theories).

Elementary idea of L.C.A.O. and concept of united atoms in M.O. Theory bonding and anti-bouding, non-bonding orbitals, M.O. configurations of simple diatomic molecules (H_2, He_2, N_2 O_2, C_2, B_2, F_2, Co, NO and their ions), Elementary idea Linnet double quartet theory.

Acids and Bases : Bronsted–Lowry concept of Acid-base reaction, Relative Strength of Acids, mechanism of Proton Transfer, amphoterism, type of Acid Base reactions, Levelling solvents. Lux-flood concept, Lewis Acid-Base concept, classification of Lewis Acids (Elcctrophilic and Nucleophilic displacements) Usanovich concept. Hard and Soft Acids and Bases (H.S.A.B.), Application of H.S.A.B. Principle.

Hydration energy and standard electrode potential (applications in interpretation of inorganic reactions).

Paper II : *Organic Chemistry* *50 Marks*

Introduction to organic Chemistry : Its interaction with everyday life.

Purification of Organic Compounds : Paper, thin-layer, column and gas chromatographic techniques. Criteria of purity of organic substances. Structural and electronic formulae. Tetrahedral concept of Carbon Compounds : Types of isomerism. Nomenclature. IUPAC notation. The concept of functional group and classification of organic compounds. Use of Greek letters.

Physical Organic Chemistry : Hybridisation and types of bonds. Atomic and molecular orbitals. Shapes of simple organic molecules. Polarity of bonds, bond length, bond strength, bond energy. Hydrogenbond. Dipole moment. Electronic displacements—Inductive, electromeric, hyper-conjugative and resonance effects. Characteristics of ionic and homolytic reactions. Nucleophiles and electrophiles. Arrhenius, Lowry-Bronsted and Lewis concepts of acids and bases. Effects of structure on P^H P^K values.

The following are to be discussed with their mechanisms at appropriate places in the Syllabus : Wurtz synthesis, Markownikoff's rule. Haloform reaction, Aldols condensation, Cannizzaro reaction, pinacol-pinacolone rearrangement, Hofmann bromamide reaction.

Preparation, typical reactions, structure and uses of the following classes of compounds (Important members of the group to be discussed in detail) Alkanes, Alkenes, Alkynes, Diolefines. Characteristics and types of organic reactions : Addition, elimination, substitution and rearrangement (Only an elementary idea of the mechanistic aspects to be discussed.)

Allylic compounds and their special characteristics. Free radical substitution in alkanes and alkenes.

Alkyl halides and their importance in synthesis. Organometallic compounds of magnesium and lithium.

Monohydric alcohols (Semi-micro determination of active hydrogen and acetoxyl groups) Glycels, glycerol, others (Zeisel's semi-micro determination of methoxyl groups), epoxides, thiols and thioethers. Nitroalkanes, nitriles and isonitriles. Monofunctional amines. Aldehydes and ketones, monocarboxylic acids and their derivatives. Halogen substituted acids.

50 *Marks*

Paper III : ***Physical Chemistry***

Kinetic Theory of Gases : Expression for the pressure exerted by the molecules of a gas. Derivation of gas laws, collision number, collosion frequency, collosion diameter and mean free path of molecules of a gas (including temperature and pressure dependence). Viscosities of gases, relation between mean free-path and coefficient of viscosity (γ): temperature and pressure dependence of η, calculation of σ from η. Degrees of freedom of motion, principle of equipartition of energy. Molecular basis of specific heats. Barometric formula and its use for determination of Avogadro's number, Maxwell distribution law of velocities, application to the calculation of molecular velocities and energy distribution curves at different temperatures. Calculation of the most probable, average and root-mean-square velocities of molecules. Real gases, compressibilily factor,

deviation from ideality: various equations of state of real gases with special emphasis on van der Walls equation of state and its application to the calculation of Boyle temperature, second virial coefficient and molecular diameter. Intermolecular forces and liquefaction of gases, critical state, relation between critical constants and van der Walls constants. Continuity of state, law of corresponding states, derivation of the reduced equation of state.

Liquid State : Qualitative treatment of the structure of the liquid state including various approaches to the structure of liquids. Radial distribution function, Physical properties of liquids (surface tension, parachor, viscosity, refractive index).

Ionic Equilibria : Ionic product of water; P^H Mathematical treatment of multistage equilibria, ionization of acids, bases and salts, hydrolysis P^H changes in acidbase titrations (weak and strong) involving not more than two stages in aqueous medium; acid-base indicatior; common on effect. Buffer solutions, buffer index, buffer capacity. Solubility product and its applications in analysis. Complexions in solutions, concept of stability constant.

Conductance: Conductance (metallic and electrolytic): Faraday's laws of electrolysis, conductivtiy and its measurement, equivalent and molar conductance, Kohlrauch law of independent migration of ions, variation of equivalent conductivity with concentrations of weak and strong electrolytes and its qualitative explanation using Arrhenius and Debye-Huckel theories. Wien effect, Debye-Falkenhagen effect; Walden's rule Transference numbers and their experimental determination, using Hittorfs' and moving boundary methods. Anamolous transference numbers, ionic velocities and mobilities. Application of conductance for determining the solubility product; degree of ionization, ionic product of water and hydrolysis. constant.

Conductometric titrations.

Chemical Kinetics: Order of a reaction (including fractional and negative orders), molecularity, Rate laws: differential forms, (Integrated forms upto second order only) experimental methods for determination of order of a reaction, steady state approximation and reaction

omplex reactions, opposite, parallel, consecutive and

chain reactions and their differential rate equations (integrated rate equation only for first order reactions). Temperature-dependence of reaction rate, Collision theory of reaction rate, Collision theory of reactions (Lindeman's mechanism). Absolute reaction rate theory (qualitative). Primary salt effect in ionic reactions.

Adsorption and Catalysis : Hmogeneious and Heterogeneous catalysis: Adsorption, Physical adsorption and chemisorption, various types of adsorption, isotherms (including qualitative discussion of BET equation and its use in surface-area determination); nature of adsorbed state. Heterogeneious catalysis: Kinetics of catalytic decompositions, promotors and inhibitors. Acid-base catalysis, enzyme reactions (Michaelis-Menten equation).

PRACTICAL TEST

I. *Inorganic Chemistry* :

Practicals	—	15 Marks
Viva-voce	—	5 Marks
Laboratory record	—	5 Marks

1. *Preparation of the following* :—
   (a) Complex Salts (at least three preparations)
   (b) Sodium peroxoborate
   (c) Cuprous Chloride
   (d) Manganese (III) Phosphate.

2. *Chromatographic Separation* : Typical group separations of the cations of the following metal combinations using paper chromato-graphy:
   A_g, P_b, and H_g; P_b, B_i, C_u, and C_d; A_s, S_b, S_n; F_e, A_l and C_r; C_o, N_i, Z_n and M_n.

3. *Volumetric Analysis* :
   (a) Acid-base titrations (combinations of strong and weak acids and bases).

(b) Oxidation-reduction titrations (using KM_nO_4 and $K_2C_{r_2}O_7$).

II. *Organic Chemistry*

Practicals	—	15 Marks
Viva-voce	—	5 Marks
Laboratory record	—	5 Marks

III. Physical Chemistry

Practical work	–
Viva-voce	—
Laboratory Record	

1. Determination of viscosities of liquids :
   (i) Pure liquids, (ii) Binary mixtures of liquids,
   (iii) Effects of temperature on viscosity of a simple liquid.
2. Measurement of surface tensions of (i) Pure liquids (ii) Binary mixtures of liquids.
3. Chemical Kinetics, (i) Acid hydrolysis of an ester (ii) Saponification of ester (iii) Persulphate–iodine reaction and the effect of C_u^{+2} or F_e^{+3} ions on it.
4. Adsorption (Acetic Acid on active charcoal).
5. Solubility (solubility curve of benzoic acid in water, determination of $\triangle$ H).
6. Refractive index measurements of (i) Pure liquids, (calculation of molar refractions, and (i) solutions.

B.Sc. (Honours) Part-II examination in Chemisiry, 1993

Paper IV—Inorganic Chemistry **50 Marks**

1. *General Principles of metallurgy*

Chief modes of occurrence of metals based on standard electrode potentials, principles of various concentration methods, calcination, roasting and smelting. Role of carbon and other reducing agents; electrolytic reduction, hydrometallurgy, Ellingham diagrams. Methods of refining and purification (electrolytic, chromatographic, ion-exchange, solvent extraction, oxidative refiining, parting process zone refinding, Kroll's process, van Arkel de Boer method, Von Bolten method, Mond's process).

2. *Hydrogen*

Isotopes, various forms of molecular hydrogen, solvated proton, hydrides and their classification (ionic, covalent and interstitial).

3, Chemistry of elements and their compounds (Groups IA to Group IVA).

General trends in groups: electronic configuration, atomic radii, ionic radii, ionization potential, electron affinity, electronegativity, oxidation states (relative stability and stereochemistry), aqueous chemistry and inert pair effect.

A comparative study of the hydrides, oxides, oxo compounds. halides, sulphides, carbides, nitrides and complexes.

Analytical Chemistry (detection and estimation by gravimetric, volumetric and colorimetric methods) of Mg, Ca, S, Ba, Al, Sn, Pb (no details).

4. *Detailed study of the following (Preparation, properties, bonding and structures)*:

Metal alkyls of group I to Group III elements, boric acids and borates, boron nitride, borazines, boron hydrides, metal borohydrides. Carboranes, metal borides. Allotropes of carbon, Lamellar compounds of graphite, carbides. Silicates, silanes, silicones and siloxances.

Solution of alkali metals in liquid ammonia.

5. *Noble gases and their compounds*

Range of noble gas compunds, nature of bonding in noble gas compounds (Valence bond treatment, M.O. treatment for XeF_2, VSEPR treatment).

Preparation and properties of Kr, Ke, Rn, halides and oxo compounds, relationship of noble gas compounds to compunds of the preceeding group elements; noble gas clathrates.

Paper V : *Organic Chemistry* 50 marks

The following reactions are to be discussed with their mechanism at appropriate place in the syllabus. Reformatsky reaction, Claisen condensation, Mannich reaction, Diels-Alder reaction.

Preparation, typical reactions, structures and uses of the following classes of compounds (typical examples only).

Acetoacetic ester and Malonic ester. Preparation and synthetic uses. Keto-enol tautomerism with different examples. Dibasic acids. Hydroxy acids, lactic, malic, tartaric and citric acids. Unsaturated alcohols, aldehydes, ketones and acids, Maleic and fumaric acids. Addition reaction of unsaturated carbonyl compounds.

Urea, Ure thane, Ketene, diazomethane and diazoacetic ester. Stereochemistry and Mechanism (Simple examples only).

Stereoisomerism-Geometrical isomerism and methods of detmining the geometry. Unsaturated dibasic acids-maleic and fumaric acids. E and Z designation of geometrical isomers. Optical isomerism. Specific and molar rotation. Chirality and Chiral molecules. Lactic, malic and tartaric acids.

Elements of symmetry and simple symmetry operations. Concepts of constitution, configuration and conformation. Conformation of ethane, n-butane and cyclohexane. Newman and Sawhorse representations. Configurational nomenclature. D and L designations. Absolute configuration in terms of R and S notations. Resolution of racemic mixture. Cycloparaffins (C_3 to C_7). Ring strain and stability.

Displacement reactions: Concepts: of transition state and intermediates, nucleophilicity. Stereochemistry of S_n^1, S_n^2, S_n^i reactions. Effect of solvent, substrate, entering and leaving groups. Elimination (E_1 and E_2 with typical examples).

Elimination versus Substitution. Walden inversion.

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

Prper VI—Physical Chemistry 50 *Marks*

Chemistry Thermodynamics: Mathematical techniques: partial differentitation, total dfferentials, exact differentials, homogeneous functions. Euler's Theorm: Intensive and extensive variables, State and path variables. Isolated, closed and open systems; Thermodynamic functions. Zeroth law of thermodynanics.

First Law: Internal Energy (E), Enthalpy (H); equivalence of heat and work (Jourke's experiment), relation between C_p and C_v Calculation of W, E and H for expansion of ideal and real gases under isothermal and adiabatic conditions, for reversible and irreversible processes including free expansion. Heat of formation (standard state and standard heats of formation), bond energy, bond dissociation energy and resonance energy (calculations from thermo-chemical data). Heats of solutions: integral and differential. Heats of dilution (including heats of infinite dilution). Heats of neutralisation, heat of ionization and heat of formation of ions; use of Born-Haber Cycle for calculation of lattice energy. Kirchoff's equation, maximum flame temperature and its calculation.

Second Law :

Various statements of the law, concept of entropy (S) Thermodynamic scale of temperature, efficiency of Carnot Cycle molecular interpretation of entropy.

Third Law : (Statement of the Third Law including the concept of residual entropy), calculation of entropy for reversible and irreversible processes, Gibbs free energy (G) and Helmholtz free energy (A). Variation of S. G and A with P, V and T. Joule-Thompson experiment, Relation between Joule-Thomson coefficient and other thermodynamic quantities ; inversion temperature. Gibbs-Helmholtz equation, Maxwell relations. Thermodynamic equation of states compressibility and expansion coefficients.

Systems of variable compositions : Partial molar quantities, chemical potential of ideal mixtures, changes in the thermodynamic functions in mixing of ideal gases. Criteria of thermodynamic-equilibria, degree of advancement of reaction. chemical equilibria in ideal condensed systems, concept of activity and activity coefficient. Derivation of the expression of equilibrium constant, temperature, pressure and concentration dependence of equilibrium constants (Kc, Kp). Le-Chateller principle (quantitative treatment) : equilibrium between ideal gases and a pure condensed phase ; dependence on thermodynamic functions in composition ; Gibbs-Duhem equation.

Colligative Properties : (Studied from Chemical Potential Consideration) ; Dilute solutions ; Lowering of Vapour Pressure : Raoult's law and Henry's law as limiting laws and their derivation ; osmosis ; osmotic pressure and its experimental determination.

Elevation of boiling point and depression of freezing point, calculation of molecular weight, van't Hoff factor and calculation of abnormal molecular weight, molecular weight of polymer by osmotic pressure (distinction between weight average and number average molecular weights).

Practical Test

I. *Inorganic Chemistry* :

Practicals	—	15 Marks
Viva-voca	—	5 Marks
Laboratory record	—	5 Marks

1. Iodimetry and iodometry : Cu^{2+}, As^{3+}, SbO^{+}, $S_2O_8^{2-}$, available chlorine in bleaching powder, MnO_2 in pyrolusite.

2. Precipitation titrations of $AgNO_3$ in neutral and acidic media.

3. Complexometric titrations : Zn^{++}, Mg^{++}, Ca^{++} using EDTA) and total hardness of water.

II. *Organic Chemistry* :

Practicals	—	15 Marks
Viva-Voce	—	5 Marks
Laboratory Record	—	5 Marks

Preparation of the following compounds involving single stage reactions. Methylation, Esterification, Acetylation, benzoylation, bromination, nitration, reduction, oxidation and azo dyes.

Suggested examples are :

β—naphthyl methyl ether, ethyl benzoate, methyl salicylate, amyl acetate, acetanilde, aspirin benzanilide, tribromoaniline, p-bromoacetanilide, nitrobenzene, m-dinitrobenzene, aniline, m-nitroaniline, oxidation of benzyl alcohol and benzaldehyde and methyl-orange.

III. *Physical Chemistry Practicals* :

Practicals	—	15 Marks
Viva-Voce	—	5 Marks
Laboratory Record	—	5 Marks

1. *Thermo Chemistry* :

(i) Heat of Neutralization (ii) Determination of basicity of an acid (iii) heat of solution (iv) Heat of hydration (v) Heat of dilution (H_2SO_4) (vi) partial molar enthalpy (vii) Heat of reaction (e.g.

$$CO^{2-}_3 + H_2O \rightarrow HCO^{-}_3 + OH^{-}$$

2. Determination of partial molar volumes (benzene. — toluene; acetone -- chloroform and carbon tetrachloride — benzene mixtures).

3. Determination of equilibrium constant of reaction between ethyl alcohol and acetic acid.
4. Determination of molecular weights (Victor Meyer) of single liquids and mixtures.
5. Determination of molecular weights by Rast-Method.

B.Sc. (Honours) Part III Examination in Chemistry, 1994

Paper VII—Inorganic Chemistry—A 50 *Marks*

1. *Chemistry of the elements and their compounds (Group VA to Group VII A)*

General group trends—electronic configuration ; atomic radii, ionic radii, ionisation potential, electron affinity. electronegativity, oxidation states (relative stabilities and stereochemistry), aqueous chemistry, inert pair effect, allotropy and catenation.

A comparative study of the hydrides, oxides, oxocompounds halides, sulphides, nitrides, carbides and complexes of the elements mentioned above.

Analytical Chemistry (detection and estimation by gravimetric, volumetric and colorometric methods) of As, Sb, Bi, S, Cl, Br, I no details).

2. *Detailed study of Preparation, properties, bonding and structures of the following* :

Oxides and oxy acids of nitrogen and phosphorous, hydrazine, hydrazoic acid, hydroxylamine, phosphazanes, peroxy-acids of sulphur, thionic acids, halosulphonic acids, interhalogen compounds, polyhalido anions, pseudo halogens.

3. *Study of the following* :

(i) Ion exchangers,

(ii) Reactions in non-aqueous solvents (NH_3. SO_2, HF),

(iii) Basic properties of halogons,

(iv) Pollution : environmental formation and control of air pollutants and water pollutants.

Paper VIII—Inorganic Chemis

Coordination Compounds :

Concept of coordination complexes and coordination number, - Werner's theory, isomerism in coordination compounds.

IUPAC nomenclature of coordination compounds.

Factors influencing the formation of complexes (Thermo dyanamic and kinetic stability).

Bonding in coordination compounds :

Valence bond interpretation, crystal field theory, ligand field theory, inner and outer orbital complexes,

Detection of complexes by Spectroscopic, Optical, pH-metric Conductometric Methods and Dipole measurements.

Chelates and Polynuclear complexes, Stereochemistry of complexes with coordination number 4 and 6.

Applications of complexes in analytical and biological fields.

Transition Metals—general group trends, with special reference to electronic configuration, colour, variable valency, magnetic properties, catalytic properties, ability to form complexes, stability of various oxidation states.

Chemistry of Ti, V, Cr, Mn, Fe, Co in various oxidation states.

Lanthanides and Actinides—electronic structure, oxidation states, colour and spectra, magnetic properties—lanthanide contraction. Elementary idea of carbonyls and nitrosyls.

Paper IX—Organic Chemistry—A 50 *Marks*

Coal tar distillation and coal tar chemicals.

Constitution of benzene, resonance and aromaticity. Huckel's rule including aromatic character of Ferrocene and tropolone. Orientation of substituents. Mechanism of electrophilic substitution (well known examples only).

The following are to be discussed with their mechanisms, at appropriate places in the syllabus. Friedel-Crafts reaction, hyper-conjugation, benzyne intermediate. Sandmeyer reaction. Perkin reaction, benzoin condensation, Benzil—Benzilic acid rearrangement. Beckmann rearrangement, Riemer-Tiemann reaction, Fischer's indole synthesis, Skarup's synthesis of quinoline.

Methods of preparation and chemistry of the following : Aromatic hydrocarbons, halogen derivatives, nucleophilic substitution, nitrobenzene, amines, diazonium salts and their reactions. Phenyl hydrazine, sulphonic acids, aromatic alcohols, phenols aldehydes, ketones, carboxylic acids.

Phenolic aldehydes, Phenolic ketones and acids, Quinones.

Naphthalene, anthracene and phenanthrene-Structure, synthesis and important derivatives. Carcinogenicity.

Synthesis, reactions, aromaticity, mechanism of substitution in and important derivatives of furan, pyrrole, indole, thiophene pyridine, Quinoline and isoquinoline.

Petroleum : Origin, fractionation, cracking, reforming and aromatisation. Petrochemicals. Synthetic fuels, octane and cetane numbers, anti-knock additives.

Polymers : Natural and synthetic. Mechanism of polymerisation. Condensation and addition polymers. Synthetic plastics, thermo-setting and thermoplastic. Urea-formaldehyde, phenol-formaldehyde plastics. Teflon, polystyrene and polyurethanes. Natural and synthetic rubbers.

Dye Stuffs—Synthesis of typical azo, triphenylmethane/phthalein and phthalocyanine dyes. Methods of determination of structure of typical azo dyes. Structure and synthesis of Indigo and alizarin. Chemistry of dyeing. Colour in relation to structure-modern views.

Application of UV, IR and NMR spectra to simple organic molecules.

Paper X-Organic Chemistry B 50 Marks

Oils, fats and waxes :

Occurrence, chemical composition and importance, Hydrogenated oils, soaps, synthetic detergents. rancidity, acid value saponification and iodine numbers.

Amino acids-synthesis and properties, Zwitterionic nature, pk values, isoelectric point and electro phoresis. Methods of synthesis of polypeptides and their general properties. Descriptive study of proteins, their classification and biological importance. Secondary structure of proteins and helix.

Typical examples of enzymes and characteristics of enzyme action. Fermentation of glucose. Kreb's cyole. Pyrimidine and purine-synthesis and reactions; Simple Ureids-reactions and synthesis. Structure, synthesis and reactions of adenine, guanine, cytosine, uracil, thymine, uric acid and caffeine. Tautomerism in purine and pyrimidine derivatives. Elementary ideas of nucleic acids.

Terpenes : Essential oils as different from mineral and fixed oils. Occurrence, isolation, classification of terpenes, chemical composition. Isoprene rule, citral and dipentene-strueture and synthesis.

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

Drugs and antibiotics: Sulpha drugs-Sulphadiazine, analgesics-aspirir phenacetin, paraacetamol, antimalarials-chloroquine, primaquine. An elementary treatment of antibiotics with a detailed study of chloramphenicol.

Paper XI-Physical Chemistry-A 50 Marks

Crystalline State :

The nature of the solid state, Law of constancy of angles Seven crystal systems. Law of rotational indices, Miller indices, indexing of the crystal faces, Qualitative idea of point and space groups. Elementary ideas of symmetry. Symmetry elements and Bravais lattices and lattice planes.

X-ray diffrection, Bragg's law, a simple account of Laupe's method, Rotating crystal method; powder pattern method, crystal structure of NaCl and KCl.

Packing in crystals; closed packed structures.

Phase Equilibria :

Phases, components, dergees of freedom, derivation of Phase Rule for non-reactive and reactive systems. Clausius Clapeyron equation, its derivation, and applications to solid liquid, liquid-vapour and solid-vapour equilibria, phase diagrams of one and two component systems. Deviations from Raoult's law and Henry's law and solution of liquids in liquids. Duhem-Marqules equation and its application to fractional distillation of binary miscible liquids. Azeotropes, lever rule, partial miscibility of liquids, miscible pairs, steam distillation. Nernst distribution law, derivation and applications; thermal analysis and solubility method for determining solid-Liquid equilibria; tyical phase diagrams of two component systems. involving autectics, congruent and incongruent melting points, solid solutions. Fractional crystallization zone refining. Three component sytsems, triangular plots, partially miscible three-liquid systems (formation of one, two and three immiscible pairs), system of two solids and a liquid including formation of binary, ternary compunds and complete series of solid solutions. Methods of wet residue and salting out.

Electrochemical Cells :

Electrolytic and Galvanic cells, Reversible and irreversible cells, Electromotive force of cell and its measurement. Free energy entropy of and enthalpy cell reactions, Nernst equation, standard electrode (reduction) potential. Types of electrodes (including reference electrode); Determination of E° equilibrium constant, solubility product, ionic product of water. Concentration cells with and without transference liquid junction potential. pH determination using hydrogen electrode, glass alectrode, quinone-hydroquinone electrode, Sb/Sb_2O_3 electrode, potentiometric (acid-base, redox and precipitation) titrations.

Paper XII- Physical Chemistry 50 Marks.

Atomic Structure and Chemical bonding

Planck's quantum hypothesis, Quant. mechanical operators.