I Semester B.Sc.

Chemistry Paper–I

(Blow up syllabus W.E.F. 2014 - CBCS)

UNIT-I

Mathematical Concepts for Chemistry — 4 hours

Logarithmic relations: Definition, some important relations like log(m+n), $\log\left(m/n\right)$, $\log m^n$, change of base ($\log_e 2 \rightarrow \log_e x$). Application in the calculation of pH.

Curve sketching: How a cure is sketched with a set of points: linear and non-linear (asymptotic) with a set of points, sketching both linear and non-linear curves. Calculation of slope in case of linear curve. Extrapolation of linear curve and arriving at a limiting value.

Parabolic curve: maximum and minimum.

Differentiation: Meaning and derivative of functions like e^x, log x, sin x, cos x, $1/x$, x^2, x^x and $\sqrt{n}$, $\frac{dy}{dx} = 0$ at maximum and minimum.

2^{nd} order differentiation: for maximum and minimum (derivation from first principles not required).

Rules of differentiation for y = u + v, y = uv, $y = \frac{u}{v}$ and y= ku, where k is constant.

Partial differentiation: Explanation, applications using the equation, H = U + PV and G = H−TS

Integration: Meaning and integrals of functions like, x, dx,x^2, $\frac{1}{x}$, $\frac{1}{x^2}$, $\frac{1}{x^3}$, x^n, e^x, sin x and cos x.

Simple problems from I and II order kinetics.

Exact and inexact differentials: Examples from internal energy and enthalpy. Definite integrals.

Probability: Some definitions, examples from atomic orbitals, wave functions and entropy.

Gaseous state — 9 hours

Introduction: Need for Maxwell-Boltzmann distribution law, mathematical expression for both mole and molecule – explanation of the terms only. Explanation of velocity distribution curves based on this law (no derivation). Mean free path, collision frequency and collision number. Definition and expressions using SI units (no derivations). Derivation of expression for most probable speed from Maxwell-Boltzmann equation. Definitions and expressions for rms velocity and average velocity (no derivations), relationships between them. Problems on rms velocity and average velocity. Andrew's isotherm on carbon dioxide and explanation of the curves (no experimental details). Derivation of critical constants T_c, P_c and V_c from van der Waal's equation and their experimental determination by Cagniard de La Tour method for T_c and P_c. Amagat's mean density method for V_c. Problems on the calculation of Tc, Pc and Vc, a and b.

Law of corresponding states, statements, reduced equation of state and explanation.

Joule-Thomson effect: Statement with explanation. Joule-Thomson co-efficient, inversion temperature-definition (no derivation). The application of Joule-Thomson effect to the liquefaction of air and hydrogen by Linde's process.

UNIT-II

Photochemistry **4 hours**

Laws of photochemistry. Grotthus-Draper law, Stark-Einstein law – Statements, differences between photophysical and photochemical processes-any four differences with examples.

Comparison of photochemical and thermal reactions with an example each. Quantum yield-definition, Magnitude of Quantum yield of photochemical combination of (i) H_2 and Cl_2 (ii) H_2 and Br_2 (iii) dissociation of HI (iv) dimerisation of anthracene: reason for low, high and medium quantum yields.

Photosensitization-definition with example, photostationary equilibrium – definition and example.

Singlet and triplet states – definitions. Fluorescence, phosphorescence, luminescence, bioluminescence and chemical sensors – definitions of all these with suitable examples.

Beer-Lambert's law-statement and its application in colorimetric estimations. Numerical problems on absorption coefficient and molar extinction coefficient.

Liquids and Solutions **9 hours**

Properties of liquids: Viscosity–definition, co-efficient of viscosity, mathematical expression, factors affecting viscosity-effect of temperature, size, weight, shape of molecules and intermolecular forces on it. Surface tension-Definition, mathematical expression, effect of temperature and solute on it.

Parachor – Definition, Sugden equation – only expression with indication of the terms and applications.

Numerical problems on viscosity and surface tension by drop number method equation.

Liquid Mixture: Review of Raoult's law of dilute solutions, ideal and non-ideal solutions. Completely miscible liquids - theory of fractional distillation of binary liquids with diagram. T-C curves for all the three types, azeotropic mixtures -examples.

Partially miscible liquids: Critical solution temperature-definitions with any one example for each type - explanations with curves (three types). Effect of addition of salt on CST of phenol-water system. Immiscible liquids, examples. Theory of Steam distillation with derivation for the expression of ratio proportion of liquid mixtures and its applications.

Distribution law: Statement, partition coefficient and condition for validity of distribution of distribution law. Application-solvent extraction (no derivation)

Dilute solutions- Review of colligative properties. Concentration terms-molality, mole fraction & problems. Determination of molecular mass of a solute by (i) Berkeley-Hartley's method (ΔT_b) (ii) Beckmann's method (ΔT_f) and (iii) Landsberger's method. Numerical problems on determination of molecular mass.

UNIT-III

Periodic Table and Periodic properties **9 hours**

Review of the modern periodic table (with respect to classification of elements based on outer electronic configuration)

Periodic properties: Atomic and ionic radii, ionization energy, electron affinity and electro negativity-definitions. Trends in the periodic properties- across the period and down the group. Applications in predicting and explaining chemical behavior - reactivity and reducing power. Factors affecting the values of ionization energy. Determination of electronegativity by Pauling's method. Diagonal relationship and its influence on the properties on beryllium and aluminium.

Comparative study of elements of alkali and alkaline earth metals. Chalcogens and halogens with respect to electronic configuration, atomic and ionic radii, ionisation energy and electronegativity. Halides, oxides and carbonates of alkali and alkaline earth metals. Hydrides of chalcogens and halogens-comparative study of all these with respect to their reactivity.

Analytical Chemistry **4 hours**

Errors: Classification- determinate and indeterminate types, minimization of determinate errors, accuracy and precision-definitions. Significant figures- definition, rules for computing significant figures and their computations with an example.

Equivalent weights of acids-definition, examples for a monobasic and a dibasic acid, Equivalent weights of bases-definition, sodium hydroxide and barium hydroxide as examples, Equivalent weights of salts-definition with sodium carbonate as an example, Equivalent weights of oxidizing and reducing agents-definitions, examples of potassium dichromate, potassium permanganate, ferrous ammonium sulphate. Methods of expressing concentration of solutions in terms of normality and molarity and their definitions. (the method of preparation of 1N and 1M solutions are to be emphasized). Numerical problems on normality & molarity.

UNIT-IV

Basic concepts in organic chemistry **4 hours**

Bond cleavage - Homolytic and heterolytic - Explanation with examples for each type. Types of reagents: Electrophilic and nucleophilic reagents-meaning, examples for each type. Reactive intermediates - generation and relative stabilities of carbocation, carbanion, carbon free radicals and carbenes - explanation for relative stability and reactivity based on inductive, resonance and hyperconjugative effects.

Types of reactions: addition, substitution and elimination-explanation examples for each type of reaction .Concept of isomerism – structural isomerism, stereo isomerism, geometrical and optical isomerism, chiral center - definition and examples. Tautomerism (keto-enol): explanation with an example.

Aliphatic Hydrocarbons **9 hours**

Alkanes: Sources, Nomenclature of branched chain alkanes, preparation of symmetrical and unsymmetrical alkanes: Corey- House reaction and Wurtz reaction - their merits and demerits. Conformational analysis of n-butane, Sawhorse and Newman projection formulae to be used -Energy profile diagram.

Cyclo alkanes: Nomenclature. Methods of preparation from (1) dichloropropane, (2) cyclopentanone (3) benzene. Explanation for stability based on heat of hydrogenation data. Baeyer's strain theory and its limitations, Sachse - Mohr theory of strainless rings; cyclopropane ring - banana bonds.

Alkenes: Preparation of alkenes by Wittig reaction-stereo selectivity. Addition of HX to unsymmetrical alkene - Markownikov's rule and anti Markownikov's addition with mechanisms. Reactions: Hydroboration - oxidation, reduction, oxymercuration - demercuration, epoxidation-general reactions, with an example of ethene (or propene).

Mechanism of oxidation with $KMnO_4$ and OsO_4. Ozonolysis- mechanism and its importance.

Dienes: Classification- isolated, conjugated, cumulated-one example for each type. Structure of allene and butadiene.1,2-addition and 1,4 addition reactions. Diels Alder reaction: 1,3-butadiene with maleic anhydride as an example.

Alkynes: Methods of preparation: dehydrohalogenation of vicinal and germinal dihalides and higher alkynes from terminal alkynes. Reactions-metal ammonia reduction and its significance.

Oxidation with $KMnO_4$, acidic nature of terminal alkynes with example of reaction with ammoniacal solutions of silver nitrate and cuprous chloride.

Allotment of marks in setting the question papers

Chemistry Paper-I(CBCS)

Note: The questions from Review part should be avoided while setting the semester Question Papers

Sl.No.	Name of the chapter	No. of hours	marks
1	Mathematical concepts	04	08
2	Gaseous state	09	16
3	Photochemistry	04	08
4	Liquids and solutions	09	18
5	Periodic table and periodic properties	09	18
6	Analytical chemistry	04	08
7	Basic concepts of organic chemistry	04	08
8	Aliphatic hydrocarbons	09	18
Grand total		52 Hours	102

R. VINAYA KUMAR
CHAIRMAN
B.O.E. in Chemistry (UG), 2015-16
Bangalore University
Bengaluru

27/7/16
Prof. L. GOMATHI DEVI
Chairperson, DOS in Chemistry
Bangalore University
Central College City Campus
Bangalore - 560 001.

II Semester B.Sc.

Chemistry Paper – II
(Blow up syllabus W.E.F. 2014 - CBCS)

UNIT - I

Quantum Mechanics and Atomic Structure **13 hours**

Review of Bohr's atomic model, Derivation of expressions for radius, energy and ionization energies of hydrogen and hydrogen like species. Numerical Problems. Limitations of classical mechanics. Wave particle duality, Uncertainty principle-statement (both in words and mathematical form).

New quantum mechanics: Sinusoidal wave (explain sinusoidal wave) equation (classical wave mechanics); Schrodinger wave equation- derivation. Postulates of quantum mechanics.

Significance of terms: (i) Hamiltonian operator (ii) Eigen function (significance of ψ and ψ^2);(iii) Eigen values. Application of Schrodinger equation to the (i) particle in one dimensional box (derivation required) (ii) hydrogen atom (detailed solution not required). Expressing the solution as a product of $\psi_{n,\ l.\ m}(r, \Theta, \Phi) = n,\ l.\ (r)\ \psi\ l.\ m(\Theta, \Phi)$

Explanation of quantum numbers (only qualitative): definition and significance. Calculation of l, m and s for a given values of n (1, 2 and 3). Radial probability distribution and angular probability distribution. Orbitals-definition and difference between an orbit with orbital. Shapes of s, p and d orbitals.

UNIT-II

Chemical bonding **13 hours**

Ionic bond: Lattice energy: definition and significance. Born-Haber cycle for NaCl and MgO.Born-Lande equation (derivation not required, problems on Born-Lande expression to be worked out). Calculation of lattice energies of NaCl and MgO, effect of lattice energy on solubility of ionic compounds.

Covalent bond: Valence bond approach- postulates of valence bond theory. Hybridization-definition and directional characteristics of sp, sp^2, sp^3, sp^2d, sp^3d^2. Formation and Shapes of $BeCl_2$, BF_3, $SiCl_4$ PCl_5 and SF_6.

VSEPR theory: statement. Examples with reference to shapes of CH_4, NH_3, NH_4^+, H_2O, BrF_3 and ICl_2^-.Molecular orbital theory: H_2, He_2^+, Be_2, N_2, O_2, O_2^-, O_2^{2-}, O_2^+ and CO. (bond order, stability and magnetic properties to be discussed). Polarization concept: Fajan's rule-statement, explanation with examples, bond length, bond angle and bond energy-definitions. Polar and non-polar molecules-examples. Dipole moment-definition, unit, examples with zero and definite dipolement values.

Weak interactions: (i) Hydrogen bond: Intra-molecular and Inter-molecular types, examples. Anomalous properties of HF, H_2O, NH_3 and alcohols, carboxylic acids, nitrophenols and biomolecules (ii) van-der Waal's forces: Noble gases and molecular crystals (dry ice, iodine and solid SO_2).

Metallic bond: Band theory, electrical properties of metals, semiconductors and insulators.

UNIT-III

Silicates **2 hours**

Definition, Structure of SiO_4^{4-}.Classification of silicates based on the structure. Zeolites: their structure and applications.

Noble gases **3 hours**

Introduction, isolation of Helium from Natural gas and applications of noble gases. Preparation properties and structures of fluorides and oxides of Xenon (XeF_2, XeF_4, XeF_6, XeO_3, XeO_4): methods of preparation. Properties of XeF_2 and XeF_4: Oxidizing reaction with water. XeF_6-reaction with silica and water. XeO_3-reaction with base-disproportionation reaction, reaction with water. (XeO_4-only preparation, properties not included).

General study of d and f block elements **8 hours**

Transition elements: electronic configuration of 3d series, atomic and ionic radii, ionisation energy, oxidation states, redox potentials, spectral and magnetic properties-calculation of magnetic moments of transition metal ions, catalytic activity, interstitial compound formation.

Lanthanides and Actinides: Electronic configuration, atomic and ionic sizes, lanthanide contraction and its consequences. Oxidation states, spectral and magnetic properties, comparison of oxidation states, complex formation and magnetic properties of d and f block elements. Ion-exchange method for separation of lanthanides.

UNIT-IV

Aromatic hydrocarbons **9 hours**

Nomenclature, structure of benzene - using molecular orbital theory. Criteria for aromaticity-Huckel's rule. (examples: cyclopentadienyl anion, cycloheptatrieneyl cation, benzene, naphthalene, anthracene and phenanthrene). Anti-aromaticity: definition. General mechanism of aromatic electrophilic substitution. Mechanism of nitration of benzene including evidence for the formation of nitronium ion, energy profile diagram and isotopic effect. Orienting influence of substituents in toluene, chlorobenzene, nitrobenzene and phenol towards electrophilic substitutions reactions.

Aromatic nucleophilic substitution via benzyne intermediate, mechanism with evidences for the formation of benzyne by trapping with anthracene. Birch reduction-statement with an example.

Side chain oxidation of toluene to benzaldehyde and benzoic acid.

Oxidation of naphthalene to phthalic acid, phthalic anhydride and naphthalene 1,4-napthaquinone. Anthracene to anthraquinone and phenanthrene to phenanthraquinone.

Diels-Alder reaction-statement with an example of the reaction between anthracene with 1,2-dichloroethene.

Alkenyl benzenes: Styrene, cis- and trans-stilbenes-structures and their preparations.

Biphenyl: Preparation by Ullmann reaction.

Organic halogen compounds **4 hours**

Alkyl halides: Nomenclature. Nucleophilic substitution reactions - S_N1 andS_N2 mechanisms with energy profile diagrams. Effect of (i) nature of alkyl groups (ii) nature of leaving groups (iii) nucleophiles and (iv) solvents on S_N1 and S_N2 mechanisms. Elimination reactions - E_1 and E_2 mechanisms; Hofmann and Saytzeff eliminations-explanation with mechanism.

Aryl halides: Preparation by halogenation. Relative reactivity of alkyl, allyl, vinyl, aryl andaralkyl halides towards nucleophilic substitution.

Allotment of marks in setting the question papers
Chemistry Paper - II (CBCS)

Note: The questions from Review part should be avoided while setting the semester Question Papers

Sl.No.	Name of the chapter	No. of hours	marks
1	Quantum Mechanics and atomic structure	13	25
2	Chemical bonding	13	25
3	Silicates	02	04
4	Noble gases	03	06
5	General study of d and f block elements	08	16
6	Aromatic hydrocarbons	09	18
7	Organic halogen compounds	04	08
Grand total		52 Hours	102

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III Semester B.Sc.
Chemistry Paper – III
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UNIT - I

Chemical Kinetics 7 hours

Review of terms - Rate, Order and Molecularity.

II order reactions, definition with examples. Derivation of expression for the rate constant of a second order reaction with a = b and a ≠ b. Half life period. Definition and derivation for the expression for half life of a second order reaction with a = b. Mean life period of a reaction - definition, expression for mean life period of a II order reaction (a=b). Problems on rate constant (a=b); half life period, mean life period and order of reaction.

Determination of order of reaction: differential method, method of integration, method of half life period and isolation method.

Theories of reaction rates: Effect of temperature on rate of reaction – temperature coefficient and probability distribution curve of effective molecules with rise in temperature of 10^{o}; Arrhenius equation-indication of the terms involved, concept of activation energy, threshold energy definitions with energy profile diagram. Problems on Arrhenius equation in calculating energy of activation and rate constants.

Simple collisions theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects. Limitations of collision theory. Steady state approximation statement and Lindemann's hypothesis-postulates. Explanation of the hypothesis using concentration dependence in deciding the order of a reaction.

Experimental determination of kinetics of (i) inversion of cane sugar by polarimetric method (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

Thermodynamics -I 6 hours

Review of terms. Exact and inexact differentials, I law of Thermodynamics – statement. Mathematical expression with explanation of the terms. Derivation of expressions for work done in isothermal and adiabatic expansion and compression of an ideal gas (IUPAC sign conventions to be used). Numerical problems. Heat capacity of a gas at constant pressure and constant volume, derivation of the relationship between C_p and C_v. Relation between P, V and T in an adiabatic process to be derived. Derivation of Kirchoff's equation. Numerical problems on Kirchoff' equation, C_p and C_v.

Spontaneous and non-spontaneous processes definitions with suitable examples.

Second law of thermodynamics: Limitations of I law of thermodynamics with illustrations. Need for II law of thermodynamics, different ways of stating II law with respect to heat and spontaneity. Other forms of II law of thermodynamics. Concept of entropy and its physical significance- illustrations with order, disorder, physical and chemical processes and probability.

Heat engine-Carnot's cycle and derivation of the expression for its efficiency based on entropy concept. Problems based on efficiency equation. II law in terms of efficiency (η).

Change in entropy in reversible and irreversible processes (derivations required). Calculation of entropy changes in reversible isothermal and reversible adiabatic processes. Phase transitions in terms of Entropy (Fusion, vaporization, sublimation and polymorphic changes) in terms of entropy. Limitations of the entropy concept of spontaneity. Problem on Phase transitions.

UNIT-II

Thermodynamics –II 4 hours

Gibb's free energy: Work function, Chemical potential definitions, and physical significance. Relationship between free energy and work function. Criteria for equilibrium, spontaneous and non-spontaneous processes based on free energy. Gibb's-Helmholtz equation-Derivation. Change of free energy with respect to temperature and pressure. Mention of temperature coefficient, van't Hoff isotherm (derivations included), $\Delta G^o = -RT \ln K_p$ – Problems. Derivation of van't Hoff reaction isochore and Clausius-Clapeyron equation. The applications of Clausius-Clapeyron equation to ΔT_b and ΔT_f determination (thermodynamic derivation not required).

Qualitative treatment of Nernst heat theorem and III law of thermodynamics-statement only. Elementary concept of residual entropy.

Surface chemistry 4 hours

Review of surface phenomena.

Theories of adsorption: Adsorption isotherms- Freundlich adsorption isotherm – equation and limitations. Langmuir adsorption isotherm and BET equation (derivation not included).

Adsorption indicators: definition and examples. Surface film on liquids-different types.

Catalysis: Types and theories with examples (intermediate compound theory and adsorption theory). Heterogeneous catalysis: surface reactions, unimolecular, bimolecular surface reactions. pH dependence of rate constant of catalysed reactions. Autocatalysis with examples.

Organic and Inorganic polymers 3 hours

Differences between inorganic and organic polymers. Polymerization: definition. Types i) Addition polymerization: definition with examples: Polystyrene preparation and its partial structure ii) condensation polymerization: definition with examples: Nylon-66 preparation and its partial structure. Molecular weight of polymers: Expression for weight average and number average molecular weights. (experimental determination is not required).

Preparation, partial structure and applications of the following types of polymers:

(1) Plastics: (i) Thermosetting plastics: phenol-formaldehyde.
(ii) Thermo softening plastics: PVC.

(2) Fibres: acrylic- polyacrylonitrile, polyamide- Nylon 6,6, polyester: types- PET and PEDT with an example each (reactions not required).

(3) Rubber: Neoprene (4) Fluorocarbons: Teflon (5) Silicones

Compounds of non-metals **2 hours**

Boron and its compounds: Synthesis by any one method, structure and applications of diborane, borazole and boron trifluoride.

Halogens and its compounds: Bleaching powder-composition, manufacture with diagram and applications.

UNIT-III

Metallurgy **5 hours**

Ellingham's diagrams: principle, salient features, Curves corresponding to formation of CO, CO_2 and oxides of Cr, Al, Mg, Ca, Hg and Ag. Applications with reference to selection of reducing agents using Carbon for ZnO and Al for Cr_2O_3.

Extraction of the following metals: (i) Nickel from pentlandite ore (ii) Thorium from monazite sand (iii) Uranium from pitch blende (iv) Plutonium from nuclear waste.

Alcohols and thiols **8 hours**

Introduction and classification: monohydric, dihydric and trihydric alcohols with an example each. 1^o, 2^o and 3^o alcohols with an example each. Methods of preparation: (i) from carbonyl compounds – by the reduction of aldehydes and ketones (by Meerwin-Pondorff-Verley reaction) (ii) from acids and esters (by reduction with $LiAlH_4$) (iii) hydroboration-oxidation of alkenes and (iv) hydration of alkenes.

Reactions of alcohols: acidic nature-reaction with sodium, esterification, oxidation of alcohols with $KMnO_4$. Comparison of the reactivity of 1^o, 2^o and 3^o alcohols-Lucas test and oxidation with $K_2Cr_2O_7$-with equations.

Glycols: Preparation from alkenes using OsO_4, $KMnO_4$ and from epoxides. Oxidation of glycols by periodic acid and lead tetraacetate with mechanisms. Pinacol-pinacolone re-arrangement.

Glycerol: Preparation from propene and from oils/fats. Reactions of glycerol (i) nitration (ii) action of concentrated H_2SO_4 and (iii) oxidation by periodic acid. Uses of glycerol.

Thiols: Nomenclature. Methods of preparation (Ex: methanethiol). Chemical reactions of methanethiol with (i) sodium (ii) NaOH (iii) metal oxides (iv) formation of thioesters and (v) oxidation with mild oxidising agent (H_2O_2) and strong oxidising agent (HNO_3 or HIO_4). Uses of dithanes. Introduction of umpolung character (reversal of polarity) in carbonyl compounds taking 1,3-dithane as an example.

UNIT-IV

Phenols **3 hours**

Classification. Acidic nature - Comparison of acidic strength of phenol with alcohols and monocarboxylic acids. Effect of electron withdrawing group (NO_2) and electron donating group (CH_3) on acidity of phenols at o-,m-,p- positions. Pechmann reaction. Mechanisms of Reimer-Tiemann and Kolbe-Schmidt reactions. Industrial applications of phenols: Conversion of phenol to (i) aspirin (ii) methyl salicylate (iii) salol (iv) salicyl salicylic acid - reactions with conditions.

Ethers and Epoxides **4 hours**

Ethers: Methods of preparation - (i) dehydration of alcohols (ii) Williamson's ether synthesis with diethyl ether as an example. Reactions - Ethers as Lewis bases (complexation with metal ions), cleavage and auto-oxidation. Ziesel's method.

Epoxides: Definition**,** Preparation using per acids, Darzen's reaction. Reactions of mono and 1,2-disubstituted epoxides with (i) carbon nucleophiles (Ex: CH_3MgI) (ii) nitrogen nucleophiles (Ex: NH_3) (iii) reduction with $LiAlH_4$.

Fertilizers **4 hours**

Introduction: (need of fertilizers), functions of essential plant nutrients (N, P, K). Classification of fertilizers -nitrogeneous, phosphatic and mixed fertilizers with suitable examples. Manufacture of urea and super phosphate of lime and their uses. Fertilizer industries in India.

Organometallic compounds **2 hours**

Preparation and synthetic applications of Grignard reagents. Preparation of methyl magnesium iodide. Applications in the synthesis of ethanol, acetic acid, acetaldehyde and acetone from methyl magnesium iodide. Organolithium compounds - preparation from methyl iodide and synthetic applications-preparation of methane and ethanoic acid. Lithiumdialkylcuprates-preparation from methyl iodide.

Allotment of marks in setting the question paper
Chemistry Paper - III (CBCS)

Note: The questions from Review part should be avoided while setting the semester Question Papers

Sl.No.	Name of the chapter	No. of hours	marks
1	Chemical kinetics	07	14
2	Thermodynamics-I	06	12
3	Thermodynamics-II	04	08
4	Surface chemistry	04	08
5	Organic and inorganic polymers	03	05
6	Compounds of non-metals	02	04
7	Metallurgy	05	10
8	Alcohols and thiols	08	15
9	Phenols	03	06
10	Ethers and epoxides	04	08
11	Fertilizers	04	08
12	Organometallic compounds	02	04
Total		52	104

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IV Semester B.Sc.

Chemistry Paper – IV
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UNIT – I

Phase equilibria 7 hours

Review of equilibrium in systems and factors affecting equilibrium.

Explanation of the terms with examples: phase (P), component (C) and degree of freedom (F). Phase rule - statement, significance and derivation. Applications of phase rule: one component systems - water and sulphur systems - phase diagram and explanation of the curves, areas, triple point, transition equilibria. Effect of pressure on freezing point of water, melting point of monoclinic sulphur and transition temperature of rhombic sulphur; calculation of degree of freedom. Two component systems – types, condensed phase rule, temperature - composition phase diagrams for simple eutectic systems such as water–potassium-iodide and lead-silver systems; explanation of effect of mixing of two solids on melting point of a component, eutectic point ,eutectic mixtures, effect of temperature on the solubility of KI. Desilverisation of lead by Pattinson's process. freezing mixtures - preparation and examples.

Solid state 6 hours

Review of crystalline and amorphous solids, anisotropy, types of crystalline solids, space lattice and unit cell.

Laws of crystallography – law of rational indices, law of constancy of interfacial angles, law of constancy of symmetry elements. Symmetry elements in crystals: plane of symmetry- rectangular and diagonal planes. Axis of symmetry: two fold, three fold and four fold axes. Centre of symmetry; illustration using a simple cubic crystal. Crystal systems –introduction of crystal parameters –a, b, c and α, β, γ; classification into seven systems (an example each, no diagrams required); Bravais lattices- explanation using cubic system (diagrams of primitive, face centered and body centered cubes with an example each). Weiss and Miller indices – calculation and use of h k l symbols; sketching of 100, 110, 111 planes in a cubic crystal; calculation of inter planar spacings in a simple cubic crystal, problems.

X-ray diffraction of crystals - derivation of Bragg's equation and problems.

Liquid crystals: explanation of the liquid crystalline state; types –smectic, nematic and cholesteric; examples and applications.

Superconducting solids: explanation of the phenomenon of superconductivity using mercury as an example; T_c high temperature superconductors – example and applications.

UNIT-II

Water Technology 3 hours

Types of impurities present in water: Physical (suspended, colloidal), Chemical (high content of chlorine, calcium and magnesium salts) and biological (algae, fungi and bacterial). Causes for the

hardness of water. Temporary hardness due to magnesium hydrogen carbonate and calcium hydrogen carbonate, permanent hardness due to calcium and magnesium sulphates. Permissible levels of ions present in water: F^-, Cl^-, NO_3^-, PO_4^{3-}, Ca^{2+}, Mg^{2+} and silicates. Treatment of water for domestic and industrial purposes by (i) Demineralisation of water by ion exchange method: principle and process. (ii) Reverse osmosis method: principle and the process.

Nuclear and Radiochemistry **8 hours**

Review of the property of radioactivity, types of radiations and their properties, atomic number and mass number, isotopes and isobars.

Nucleus – nucleons, nuclear force, nuclear density, stability - explanation using meson theory, n/p ratio, n versus p graph. Mass defect; Binding energy - definition, graph, calculation of binding energy to show that 1 amu=931MeV. Explanation of the instability of the nuclei. Problems.

Radioactive decay law, derivation of $N=N_0\ e^{-\lambda t}$, half life period of a radioisotope, relationship between half life and decay constant, numerical problems. Radioactive equilibrium - explanation, introduction of the terms parent and daughter elements. Group displacement law - statement and explanation taking examples; radioactive series - U, Th, Ac and Np series (mention of the first and last stable elements, number of α and β particles. Type of series namely 4n, (4n+1), (4n+2) and (4n+3).

Artificial radioactivity: Rutherford's first artificial transmutation, induced radioactivity; nuclear reactions – differences between chemical and nuclear reactions; reason for the large amount of Q value; symbolic representation of a nuclear reaction, introduction of the term projectile, comparison of neutron, proton, α, γ and deuteron as projectiles. examples of nuclear reaction induced by γ-radiation, α, n, p and deuteron . Nuclear fission - explanation with an example, chain reaction, principle of atomic bomb, calculation of energy liberated, fissionable isotopes. Nuclear fusion - explanation with an example, thermonuclear reaction, advantages and disadvantages of fusion over fission, principle of hydrogen bomb. Nuclear reactors - principle, working of a thermal reactor, diagram, explanation of the terms like nuclear fuel, control rods, moderators and coolant. Breeder reactors- brief explanation of the functioning. Atomic energy programme in India. Use of radio isotopes in tracer technique - agriculture (phosphorous in agriculture research), medicine (phosphorous to check crack in bones, sodium/iodine to detect clots in blood vessels), food preservation.

Carbon dating - formation of radioactive carbon in the atmosphere. Explanation of the determination of age of wood or peat or fossil. Numerical problems on carbon dating.

Powder Metallurgy **2 hours**

Advantages of powder metallurgy- and its applications. Methods of production of metal powders: Production of tungsten powder from wolframite.

UNIT-III

Steel **5 hours**

Phase diagram of iron-carbon: explanation of the composition of austenite, ferrite, cementite and pearlite phases in the diagram.

Alloy steels: Influence of Si, Mn, Cr, Ni, Ti and W on the properties of steel and their applications. Ferro alloys: production of ferro chrome, ferro manganese and ferro silicon: diagram, equation and manufacture. Applications of alloy steels.

Carbon steel: classification based on carbon content. Heat treatment of steels: hardening, case hardening, carbiding, nitriding, tempering and annealing - definition with applications of each type.

Aldehydes and Ketones **8 hours**

Nomenclature. Preparation of aldehydes (i) from acid chlorides (Rosenmund reaction)-general reaction and from acetyl chloride. (ii) Gattermann-Koch aldehyde synthesis –benzaldehyde from benzene. Preparation of Ketones: from (i) nitriles (preparation of butanone), (ii) carboxylic acids with alkyl lithium, (iii) acid chlorides with metal alkyls- general reaction with one example each.

General mechanism of condensation with ammonia and its derivatives (NH_2-R; R = $-NH_2$, $-OH$, $-NH-CO-NH_2$).

Mechanisms of aldol condensation, Perkin condensation, Knoevenagel condensation, benzoin condensation and acetal formation.

Reduction: Reduction by $LiAlH_4$ and $NaBH_4$. Mannich reaction- example.

Mechanism of Clemmensen and Wolff-Kishner reductions.

UNIT-IV

Carboxylic acids and their derivatives **5 hours**

Nomenclature of mono, di, tri carboxylic acids. Preparation by acid hydrolysis of nitriles with mechanism. Acidic strength (pK_a values). Effect of substituents on the strength of aliphatic and aromatic carboxylic acids - (comparison of acidic strength of formic and acetic acids; acetic acid and monochloro, dichloro, trichloro acetic acids ; benzoic and p-nitrobenzoic acid; benzoic acid and p-aminobenzoic acid). Reactions: Formation of esters, acid chlorides, amides and anhydrides- explanation with an example for each. Hell-Vollhard-Zelinski reaction, decarboxylation and reduction (using $LiAlH_4$).

Di and tri carboxylic acids: Action of heat on dicarboxylic acids (oxalic acid, malonic acid, succinic acid, glutaric acid and adipic acid).

Reactions of tartaric acid and citric acid – (i) action of heat and (ii) reduction with HI.

Reactions of acid chlorides (example: acetyl chloride) - hydrolysis, reaction with alcohol, ammonia and lithium dialkylcuprates.

Reactions of acid anhydrides - hydrolysis, reaction with alcohol, ammonia.

Reactions of amides - hydrolysis, reduction, Hoffmann rearrangement.

Reactions of esters - alkaline hydrolysis, ammonolysis and alcoholysis. Mechanism of ester hydrolysis - acid and base catalysed (acyl O-cleavage: $B_{AC}2$, $A_{AC}2$; alkyl O-cleavage: $A_{AL}1$ mechanisms).

Tautomerism and Enolates **4 hours**

Tautomerism in carbonyl compounds – keto-enol tautomerism. Acidity of α-hydrogen atoms in aldehydes, ketones and active methylene compounds (example: diethyl malonate, ethyl acetoacetate and acetyl acetone).

Preparation of diethyl malonate from acetic acid and synthetic applications of diethyl malonate (preparation of monocarboxylic acids - butanoic acid, dicarboxylic acid - adipic acid, unsaturated acids -cinnamic acid, ketones - butanone, cyclic compounds - barbituric acid).

Preparation of ethyl acetoacetate (from ethyl acetate). Synthetic applications of ethyl acetoacetate (preparation of monocarboxylic acids - butanoic acid, dicarboxylic acid - succinic acid, unsaturated acids- crotonic acid, ketones - butanone).

Environmental Chemistry **4 hours**

Meaning of stratosphere. Depletion of ozone in the stratosphere causes and remedial measures. The green-house effect and its consequences. Acid rain, photochemical smog-causes, consequences and remedial measures. Treatment of sewage - primary and secondary processes. Industrial effluents- from paper industry and sugar industries. Disposal of radioactive solid, liquid and gaseous wastes.

Allotment of marks in setting the question papers

Chemistry Paper - IV (CBCS)

Note: The questions from Review part should be avoided while setting the semester Question Papers

Sl.No.	Name of the chapter	No. of hours	marks
1	Phase equilibria	07	14
2	Solid state	06	12
3	Water technlogy	03	05
4	Nuclear and radiochemistry	08	16
5	Powder metallurgy	02	04
6	Steel	05	10
7	Aldehydes and ketones	08	16
8	Carboxylic acid and their derivatives	05	10
9	Tautomerism and enolates	04	08
10	Environmental chemistry	04	07
Grand total		52	102

R. VINAYA KUMAR
CHAIRMAN
B.O.E. in Chemistry (UG), 2015-16
Bangalore University
Bengaluru

27/7/16
Prof. L. GOMATHI DEVI
Chairperson, DOS in Chemistry
Bangalore University
Central College City Campus
Bangalore - 560 001.

V Semester B.Sc.

Chemistry Paper – V (Organic chemistry)
(Blow up syllabus W.E.F. 2016 - CBCS)

UNIT - I

Stereochemistry **8 hours**

Elements of symmetry (plane of symmetry: 2, 3-dichrolobutane, tartaric acid, center of symmetry: trans-2, 4-dimethyl-trans-1,3-cyclobutanedioic acid, axis of symmetry: 1,2,3,4-tetramethylcyclobutane). Chiral molecules and achiral molecules (2-chloropropanol, 3-chloropentane).Chirality, stereogenic center (example: lactic acid, tartaric acid and 2, 3-dichlorobutane). Fischer projection formulae (lactic acid, 2-chlorobutane, tartaric acid and 2, 3-dichlorobutane).

Optical isomerism due to free rotation about single bonds**:** Enantiomers, optical activity (conditions for optically active compounds); absolute configuration of enantiomers (use of +/–, d/l, D/L notations (Examples: glyceraldehyde and lactic acid). Cahn-Ingold-Prelog sequence rules (R and S system) of nomenclature with suitable examples. Properties of enantiomers.

Meso compounds: Explanation with examples of tartaric acid and 2,3-dichlorobutane.

Diastereomers: Explanation with examples of tartaric acid, 2-bromo-3-chlorobutane) and properties. Relative Configuration of threo and erythro nomenclature (using above examples).

Racemisation: Definition and explanation using lactic acid as an example.

Resolution of racemic mixture: definition, explanation of resolution of racemic mixture of tartaric acid by chemical method and biochemical method.

Optical isomerism due to restricted rotation about single bonds- diphenyl systems: Explanation using 6, 6'-dinitrodiphenic acid as an example.

Geometric isomerism in alkenes: Definition, conditions and explanation using 2-butene and 1,2-dichloroethene as examples.

Determination of configuration of geometric isomers: cis and trans by (i) Physical methods (melting and boiling points, dipole moments, solubility) (ii)Spectroscopic methods (UV, IRevidences) (iii)chemical methods (cyclisation method: Ex-maleic acid to maleic anhydride, pK_avalues: Ex-maleic and fumaric acids). E and Z system of nomenclature (rules with suitable examples).

Geometric isomerism in oximes: Nomenclature of syn and anti isomers in oximes using benzaldoxime and acetophenone oxime as examples.

Alicyclic compounds: Conformations of four to eight membered cycloalkanes and disubstituted cyclohexanes (1,2- ,1,3- and 1,4- dimethylcyclohexanes as examples).

Bicylic systems: cis and trans- nomenclature and conformations of decalins and norbornane.

UNIT - II

Amines **5 hours**

Classification and nomenclature. Preparation of alkyl and aryl amines-reductive amination of carbonyl compounds (ethyl amine, isopropyl amine). Gabriel phthalimde synthesis (ethyl amine). Reduction of nitrobenzene to aniline. Basicity of amines in aqueous solution: Inductive, resonance, steric and solvation effects on the basicity of amines. Reaction of amines as nucleophiles (methylation and acylation). Formation of quaternary ammonium salts (reaction of tertiary amine and alkyl halide), Formation of quaternaryammonium hydroxide. Hofmann elimination reaction with mechanism. Distinguishing reactions of 1^o, 2^o and 3^o amines (Reactions with equations for Hinsbergs test). Diazotization: formation of benzenediazonium chloride. Synthetic applications of benzenediazonium chloride in the preparation of (i) chlorobenzene, bromobenzene and benzonitrile by Sandmeyer's reaction (ii) phenol (iii) phenyl hydrazine and aniline by reduction reaction and (iv) p-hydroxyazobenzene and 1- phenylazo-2-naphthol by coupling reaction.

Heterocyclic compounds **4 hours**

Introduction, classification (based on size of heterocyclic ring - 5 and 6 membered) with examples, orbital structures, resonance and aromatic character (Huckel's rule) of furan, pyrrole, thiophene and pyridine.

Methods of preparation of pyrrole (from acetylene and from ammonium mucate), furan (from mucic acid and furfural), thiophene (from acetylene and butane). General mechanism of electrophilic substitution reactions and nitration reaction of pyrrole, furan and thiophene.

Preparation of pyridine (from acetylene and from nicotinic acid) and reaction with sodamide (Chichibabin reaction). Comparison of basicity of pyrrole, pyridine and piperidine (pK_b).

Fused heterocyclic compounds (i) Indole - preparation by Fischer synthesis and nitration reaction, (ii) Quinoline-preparation by Skraup synthesis and properties - nitration.

UNIT -III

Chemistry of Natural Products **10 hours**

Carbohydrates: Introduction and classification (based on number of monosaccharide units and sugars and non-sugars) with examples. Monosaccharides: Definition with examples, classification of monosaccharides (based on functional group).

Aldoses: Structures of D-aldohexoses (glucose, galactose and mannose). Open and Haworth structures. Epimers (Example: D-galactose and D-glucose, D-glucose and D-mannose). Elucidation of open chain structure of D-glucose. Limitations of open chain structure of glucose. Mechanism of mutarotation and anomeric effect.

Elucidation of ring structure and size of D-glucose by oxidation with HIO_4 and HNO_3.

Ketoses: Structure of fructose-pyranose and furanose forms. Inter-conversion of glucose and fructose

Disaccharides: Definition with examples. Formation of glycosidic bond with examples. Haworth and conformational structures of maltose, lactose and sucrose.

Terpenes and terpenoids: Occurrence, isoprene rule and classification (on the basis of number of isoprene units, acyclic and cyclic). Elucidation of structure and synthesis of citral (from methyl heptenone) and zingiberene (from methylheptenone and p-methoxymethylmagnesium bromide). Structures of limonene, menthol, α-terpineol, camphor, β-carotene, Vitamin-A and their uses.

Alkaloids: Introduction, classification (based on heterocyclic ring present) and general characteristics. Structural elucidation and synthesis of nicotine (from succinimde). Structures and uses of ephedrine, caffeine, cocaine, atropine, quinine and morphine.

UNIT –IV

Spectroscopy of Organic compounds **8 hours**

Introduction: Electromagnetic radiation, electromagnetic spectrum, advantages of spectroscopic techniques, basic principle of spectroscopy, types of spectroscopic techniques (UV-Visible spectroscopy, IR spectroscopy, NMR spectroscopy).

UV-Visible spectroscopy: Introduction - basic principles of UV-Visible spectroscopy. Types of electronic transitions with suitable examples. Chromophores and auxochormes (with suitable examples). Blue shift and red shift (with suitable examples). Influence of conjugation on λ_{max} absorption in UV - Visible region. Comparison of UV spectra of acetone and methyl vinyl ketone. Graphical representation of spectra of 1,3-butadiene, benzene and lycopene. Advantages of UV-Visible spectroscopy.

IR spectroscopy: Introduction - Basic principles of IR spectroscopy. Conditions for IR active organic compounds. Vibrational transitions: Stretching and bending modes of vibrations. Factors affecting on position of IR absorption peak (atomic mass and force constant-electronic effects and hydrogen bonding). Types of IR region (functional group region and finger print region). Explanation of Stretching frequencies of −OH (free and H-bonded), alkyl −C−H, C≡C, C=C, C−C, C=O and C−O groups (formaldehyde, acetaldehyde, acetone, ethanol, ethylene, benzene, acetylene, acetic acid and phenol). Graphical representation (interpretation) of IR spectra of benzoic acid and methyl benzoate. Advantages of IR spectroscopy.

NMR spectroscopy: Basic principles of proton magnetic resonance: Nuclear magnetic spin quantum number, influence of the magnetic field on the spin of nuclei, spin population, saturation using radio frequency. Nuclear magnetic resonance. Chemical shift (δ values), uses of TMS as reference. Nuclear shielding and deshielding effects. Equivalent and non-equivalent protons. Effect of electronegativity of adjacent atoms on chemical shift values. Spin-spin splitting and spin-spin coupling (qualitative treatment only).Graphical representation (interpretation) of NMR spectra of simple organic compounds (i) methane (ii) CH_3−Cl (iii) CH_2Cl_2 and (iv) $CHCl_3$using shielding and deshielding effects, (iv) Cl_2CHCHO (v) 1,1,2-trichloroethane and (vi) CH_3CH_2Cl using spin-spin splitting and spin-spin coupling.

Industrial Organic chemistry **5 hours**

Synthetic dyes: Introduction: Colour and constitution (modern theory). Classification of dyes: (based on methods of application to the fibre: direct dyes, vat dyes, mordant dyes, azoic dyes and dispersive

dyes with examples). Synthesis of congo red (from benzidine), malachite green (from benzaldehyde), alizarin (from anthracene) and indigo (from aniline).

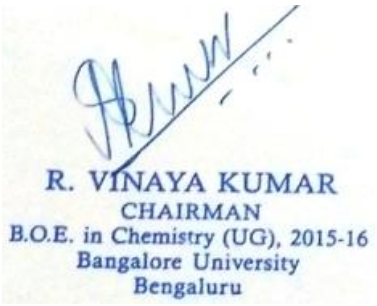
Drugs: Chemotherapy, classification of drugs (i) drugs used for the treatment of diseases due to infection (antimalarial, sulpha drugs, anthelmentics, antileprotic, antitubercular, amoebicides, antibiotics and antiseptic drugs with examples) (ii) drugs used for the treatment of diseases not due to infection (antipyretics, analgesics, anesthetics, tranquilizers and hypnotics, narcotics, anticonvulsants, cardiac or cardiovascular and diuretics drugs with examples**).** Synthesis of paracetamol (from phenol), sulphanilamide (from acetanilide) and chloramphenicol (from 4-nitro-acetophenone). Structure and uses of diclofenac and ranitidine.

Introduction to Green Chemistry- principles of Green chemistry and its application to the synthesis of ibuprofen (with and without using principles of green chemistry)

Allotment of marks in setting the question papers
Chemistry Paper - V (CBCS)

Note: The questions from Review part should be avoided while setting the semester Question Papers

Sl. No.	Name of the chapter	No. of teaching hours	Marks
1.	Stereochemistry	8	18-20
2.	Amines	5	12-14
3.	Heterocyclic compounds	4	10-12
4.	Chemistry of natural products	10	24-26
5.	Spectroscopy of org.compds.	8	18-20
6.	Industrial Organic chemistry	5	12-14
Total		40	102



V Semester B.Sc.

Chemistry Paper – VI (Physical chemistry)
(Blow up syllabus W.E.F. 2016 - CBCS)

UNIT-I

Electrochemistry-I **10 hours**

Review of electrolytes and Conductance related terms

Definition of molar conductance, determination of molar conductance of an electrolyte ($NaNO_3$ or KCl) using Wheatstone's bridge. Conductometric titrations: Definition and advantages over other conventional titrations. Principles involved in conductometric titrations with graph for strong acid-strong base, strong acid-weak base, weak acid-strong base and weak acid-weak base titrations.

Ionic mobility, absolute ionic mobility and transport number- definitions. Relationship between transport number and ionic mobility of an ion (no derivation). Determination of transport number of an ion (H^+ ion in HCl) by moving boundary method. Abnormal transport numbers- definition with an example like Cd^{2+} in CdI_2. Causes for abnormal transport numbers observed in certain systems. Numerical problems on (i) transport number calculation by moving boundary method (ii) relationship between transport number and ionic mobility (iii) molar conductance and specific conductance.

Kohlrausch's law: Statement and its applications (i) Evaluation of λ_∞ from λ_+ and λ_- for CH_3COOH and NH_4OH (ii) evaluation of degree of dissociation of a weak electrolyte - monochloro acetic acid (iii) evaluation of λ_∞ a weak electrolyte (iv) determination of solubility from conductance of saturated solutions of sparingly soluble salts (AgCl and $BaSO_4$). Numerical problems based on these. Limitations of Arrhenius theory. Qualitative account of Debye-Huckel theory -postulates, asymmetric effect (with diagram) and electrophoretic effect. Debye-Huckel-Onsagar equation for aqueous solutions of 1:1 electrolytes. Verification of DHO equation.

Galavanic cell: Conventions of representing galvanic cells-reversible and irreversible cells, requirements and examples for reversible cell (Daniel cell) and irreversible cells, representation, cell reaction. Electrode potential, Standard electrode potential, Derivation of Nernst equation for single electrode potential (free energy concept).

Numerical problems on single electrode potential of a metal and emf of cells.

UNIT-II

Electrochemistry II **5 hours**

Weston-cadmium cell: Diagram involving the representation of anode, cathode and the electrolyte. Requirements to decide Weston cadmium cell as standard cell. Construction and working of Weston cell and its numerical value of emf. Determination of emf of a cell by compensation method. Determination of E^o of Zn/Zn^{2+} and Cu/Cu^{2+} electrodes. Liquid junction potentials, elimination of liquid junction Potential using a salt bridge and conditions required for preparing a salt bridge.

Types of electrodes: (i) Metal and gas electrodes-Pt/H_2 and Pt/Cl_2 (ii) metal/metal insoluble salt electrodes-Ag/AgCl. (iii) redox electrodes-Pt/Fe^{2+}, Fe^{3+}. Reference electrodes: standard hydrogen

electrode- representation and limitations. Calomel electrode: Representation, construction and working. Quinhydrone electrode and glass electrode. Determination of pH using these electrodes. Numerical problems involving the calculation of pH using hydrogen and quinhydrone electrodes. Concentration cells: (i) emf of concentration cells (ii) determination of solubility of sparingly soluble salt taking silver chloride as example. Numerical problems: (i) calculation of emf (ii) solubility and solubility products. Redox electrodes: emf of redox electrodes. Potentiometric titration involving only redox systems. Example: Fe^{2+}/Fe^{3+}.

Ionic equilibria **3 hours**

Hydrolysis of salts of weak acids and weak bases. Ionic product of water. Deriving the Relationship between K_h, K_w, K_a and K_b. Degree of hydrolysis and its relationship with K_h. Effect of temperature and dilution on degree of hydrolysis of salt of weak acid and weak base. pH expression for the salt of weak acid - bases. Numerical problems on the calculation of K_h, h and pH of salts of weak acid and weak bases only.

Common ion effect: statement and example (ammonium hydroxide - ammonium chloride and acetic acid - sodium acetate). Buffers: Types and examples. Buffer action and buffer capacity. pH of buffers- Henderson's equation and its derivation for acidic buffer. Problems in calculating the pH of buffers. Solubility product and ionic product definitions and their applications in the precipitation of II and IV group basic radicals in the qualitative analysis of simple salt mixtures. Analytical and biological applications of buffers.

Theories of indicators (Mentioning the different theories). Acid-base theory by taking phenolphthalein as an example.

UNIT-III

Physical properties and Molecular structures **5 hours**

Polarization and orientation of dipoles in an electric field. Dipole moment, definition and examples, Induced dipole-definition and examples. (Experimental determination of dipole moment not included). Clausius-Mossotti equation (only statement). Dipole moment and structure of molecules (planar- CO_2 and BF_3 and non-planar - H_2O, NH_3 and NF_3, cis- trans isomers of 1,2-dichloroethene).

Magnetic properties-paramagnetic,diamagnetic and ferromagnetic systems, definition and examples. Electrical properties of solids: types of solids- metals, insulators and semiconductors. Pyroelectricity, piezoelectricity, ferroelectricity, inverse piezoelectricity - Definition and examples. Thomson effect, Seebeck effect and Peltier effect - definitions with examples.

Chemical Spectroscopy-I **5 hours**

The interaction of radiation with matter. Regions of electromagnetic spectrum and associated spectroscopic techniques. Origin of molecular spectra: Born-Oppenheimer approximation.

Rotational spectra of diatomic molecules: Relationship between inter-nuclear distance and moment of inertia- derivation. Expression for rotational energy. Numerical problems involving moment of inertia and bond length. Rotational energy for different quantum levels- J=0, J=1, J=2 etc. Criterion for absorption of radiation- selection rule.

UNIT-IV

Chemical Spectroscopy- II **4 hours**

Vibrational spectroscopy: Introduction, degree of freedom of polyatomic molecules - calculating the number of modes of vibration for CO_2 and H_2O molecules, diagrammatic representations of these vibrations. Hooke's law- Expression for the frequency and wave numbers of SHO-force constant and its significance. Expression for vibrational energy levels of SHO. Zero point energy - definition, mathematical expression and its significance. Numerical problems based on (i) zero point energy (ii) wave number and (iii) force constant.

Raman spectroscopy and electronic spectroscopy **3 hours**

Concept of polarisability. Pure rotation, vibration - qualitative study. Stokes and anti-Stoke's lines-selection rules. Advantages of Raman spectroscopy over IR spectroscopy.

Electronic spectroscopy: Potential energy curves for bonding and antibonding molecular orbitals. Electronic transitions - qualitative description of non-bonding orbitals and transitions between them. Selection rules and Franck-Condon principle, definitions and its diagramatic representations.

Electro analytical Methods **5 hours**

Voltametry at a dropping mercury electrodes (DME)- Types of current obtained at DME. Ilkovic equation and its applications. Current - potential relation for a cathodic process - half wave potential and its significance. Cyclic Voltametry: Principles- Experimental set up- Quantitative analysis, determination of diffusion coefficients.

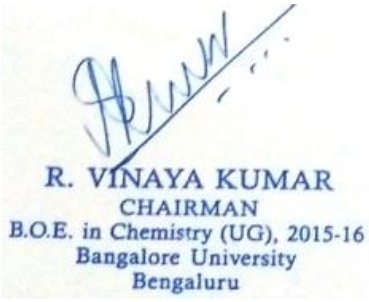
Allotment of marks in setting the question papers
Chemistry Paper - VI (CBCS)

Note: The questions from Review part should be avoided while setting the semester Question Papers

Sl.No.	Name of the Topic	No. of Hours	Marks
1.	Electrochemistry-I	10	26
2.	Electrochemistry-II	5	14
3.	Ionic equilibria	3	8
4.	Physical properties and molecular structure	5	12
5.	Chemical spectroscopy-I	5	12
6.	Chemical spectroscopy-II	4	10
7.	Raman Spectroscopy	3	8
8.	Electroanalytical methods	5	12
Grand total		40	102

Question Paper pattern

Sl. No.	Name of the Topic	Part- A	Part-B
1.	Electrochemistry-I	3Q × 2m=6m	20m
2.	Electrochemistry-II	2Q × 2m=4m	10m
3.	Ionic equilibria	1Q × 2m=2m	6m
4.	Physical properties and molecular structure	1Q × 2m=2m	10m
5.	Chemical spectroscopy-I	2Q × 2m=4m	08m
6.	Chemical spectroscopy-II	1Q × 2m=2m	8m
7.	Raman Spectroscopy	1Q × 2m=2m	6m
8.	Electroanalytical methods	1Q × 2m=2m	10m
	Total	24m	78m



VI Semester B.Sc.

Chemistry Paper – VII (Inorganic chemistry)
(Blow up syllabus W.E.F. 2016 - CBCS)

UNIT-I

Coordination and Organometallic compounds -I **10 hours**

Coordination compounds- difference between double salts and complex salts with examples. Ligands -definition and their classification (mono, bi, tri, tetra, penta and hexadentate ligands and ambidentate ligands), examples for each class.

Coordination number- definition with examples.

Nomenclature of coordination compounds in detail.

Theories of structure and bonding: explanation for the formation of complexes by Werner's Theory in detail and its limitations. EAN rule- statement with illustrations.

Valence bond theory: postulates, low spin and high spin complexes with examples, limitations of VBT.

Crystal field theory: (octahedral, tetrahedral and square planar complexes). Crystal field splitting and crystal field stabilization energies- definition and illustrations with examples. Limitations of CFT. Magnetic properties of $[CoF_6]^{3-,}$ $[Co(NH_3)_6]^{3+}$, $Fe(CN)_6]^{4-}$,$[Fe(CN)_6]^{3-}$. Spectral properties of $[Ti(H_2O)_6]^{3+}$, $[Co(H_2O)_6]^{3+}$, $[CoCl_4]^{2-}$. Isomerism in complexes: Structural isomerism - ionization, linkage, hydrate and coordination isomerism with examples. Stereoisomerism- geometrical and optical isomerism of coordination compounds with coordination number 4 and 6 with examples.

Organometallic compounds - ligands, classification (hapticity). Synthesis and structure of $K[PtCl_3(\eta^2\text{-}C_2H_4)]$ and $[Fe(\eta^5 - C_5H_5)_2]$.

UNIT-II

Coordination and Organometallic compounds – II **4 hours**

Metal carbonyls: Structures of $Cr(CO)_6$, $Co_2(CO)_8$, $Mn_2(CO)_{10}$; eighteen electron rule and its deviations with examples. Applications of coordination/organometallic compounds: cis-platin in cancer therapy, Na_2Ca EDTA in the treatment of heavy metal (Pb, Hg) poisoning, Wilkinson's Catalyst in alkene hydrogenation, Monsanto acetic acid process.

Industrial Materials- I **6 hours**

Refractories: Definition**.** Properties of a good refractory, classification, determination of PCE values.

Abrasives: Definition and classification with examples, applications, hardness-definition and magnitude of hardness, manufacture and importance of carborundum and tungsten carbide.

Glass: Properties, types, manufacture of soda glass. Composition and applications of borosilicate, metallic glass, optical glasses and polycarbonate glass, safety glass, fire and bullet proof glasses.

Ceramics: Raw materials and their roles, varieties of clay, production of ceramic ware, glazing, ceramic insulators.

Cement: Raw materials, manufacture of Portland cement (by wet process), setting of cement, grades, their significance.

UNIT-III

Industrial Materials - II **7 hours**

Paints and Varnishes: Constituents of oil and emulsion paints and their role. Constituents of varnishes.

Fuels: Characteristics, calorific value - definition and its determination using bomb calorimeter.

Coal – varieties. Gaseous fuels- advantages, constituents and their significance. Production of Coal gas, composition of LPG. Octane number-definition and significance.

Explosives: Classification, preparation of dynamite and TNT.

Propellants: Characteristics, classification and their applications.

Bioinorganic Chemistry **3 hours**

Essential and trace elements in biological systems with reference to Na^+, K^+, Ca^{2+}, Fe^{2+}, P, Cu, V and Ni. Their roles in biological systems. Metallo-porphyrins with special reference to hemoglobin, myoglobin and chlorophyll. Role of cobalamin (vitamin-B_{12}) in living systems.

UNIT-IV

Chemistry of Newer materials **10 hours**

Conducting polymers: Introduction, definition and examples- polyaniline, polyacetylene. Mechanism of conduction. Qualitative treatment of doping. Properties: elasticity with high electrical conductivities, Engineering and biological applications.

Superconductors: Introduction, definition, type-1, type-2 and atypical. Preparation of high temperature superconductor- $Y_1Ba_2Cu_3O_{x\pm\delta}$. BCS theory (qualitative treatment only) and general applications of high temperature super conductors.

Fullerenes: Introduction, definition, preparation and isolation of C_{60}. Structure and chemical reactions (redox reactions, electrophilic aromatic substitution and bromination) of C_{60}.Commercial uses of C60.Carbon nanotubes-Introduction, definition, examples and structure.

Nanomaterials: Introduction, definition and structure. Different methods of production: Sol gel synthesis, inert gas condensation, mechanical alloying (ball milling), plasma synthesis, electro deposition, and general applications.

Allotment of marks in setting the question papers
Chemistry Paper – VII (Inorganic chemistry) (CBCS)

Note: The questions from Review part should be avoided while setting the semester Question Papers

Sl.No.	Name of the Topic	No. of Hours	Marks
1.	Coordination and Organometallic compounds -I	10	26
2.	Coordination and Organometallic compounds -II	04	10
3.	Industrial materials I	06	16
4.	Industrial materials II	07	18
5.	Bio-inorganic chemistry	03	08
6.	Chemistry of newer materials	10	24
Grand total		40	102

R. VINAYA KUMAR
CHAIRMAN
B.O.E. in Chemistry (UG), 2015-16
Bangalore University
Bengaluru

27/7/16
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Chairperson, DOS in Chemistry
Bangalore University
Central College City Campus
Bangalore - 560 001.

VI Semester B.Sc.

Chemistry Paper – VIII (Biochemistry)
(Blow up syllabus W.E.F. 2016 - CBCS)

UNIT – I

Introduction to Biochemistry **2 hours**

Contributions of Lavosier, Wohler, Emil Fischer, Louis Pasteur, Embden, Meyerhof, Parnas. Hans Kreb, Michaelis and Menton, Watson and Crick, Chargaff, H.G. Khorana, Knoop, Pauling, Hopkins and Miescher.

Elemental and biochemical composition of living organisms.

Role of water in biochemical systems (mention the properties of water such as dielectric constant, surface tension, heat of vaporization, MP and BP & specific heat which makes water a solvent of life).

Carbohydrates **4 hours**

Derivatives of monosaccharides: Amino sugars ,Haworth Structure and biological importance of β-D-glucosamine, β-D-galactosamine and their N-acetylated forms: N-acetyl muramic acid (NAMA); N-acetylneuraminic acid (NANA).

Sugar acids- Open or ring structure and biological importance of D-gluconic acid, D-glucuronic acid and D-glucaric acid.

Sugar phosphates - Haworth structure and biological importance of Glucose-6-P, Fructose-6-P, Fructose-1,6-di-P, β-D-ribose-5-P and β-D-deoxyribose-5-P.

Structure (Haworth) and biological importance of oligosaccharides- Isomaltose, cellobiose, trehalose.

Polysaccharides- source, comparative account of partial structure and biological function of starch, glycogen, cellulose, chitin and inulin.

Lipids **4 hours**

Introduction, Classification -simple, complex and derived with examples.

Fatty acids - definition, classification as saturated and unsaturated with examples and structure (lauric, myristic, palmitic, stearic, oleic, linoleic, linolenic and arachidonic acids). Essential fatty acids - definition with examples.

Triglycerides - Structure of simple and mixed glycerides, properties of triglycerides- acid and alkali hydrolysis, saponification number and its significance, iodine number and its significance, rancidity (oxidative and hydrolytic), causes and prevention. Biological importance of triglycerides.

Phosphoglycerides- General structure of 3-Sn–phosphatidic acid, lipid bilayer (as in cell membrane), micelles, liposomes and its applications, structure and biological importance of lecithin, cephalin, phosphatidylserine, phosphatidylinositol.

Cholesterol: structure , biological & clinical significance, Lipoproteins- definition, types (HDL, LDL and VLDL) & clinical si gnificance. Sphingolipids - structure and biological significance of ceramide.

UNIT-II

Proteins **5 hours**

α-amino acids: Introduction, structure (Glycine, Alanine, Valine, Cysteine, Aspartic acid, Lysine, Tyrosine and proline), classification on the basis of polarity of R-groups, essential and non-essential amino acids with examples, ionic properties and reactions of amino acids with alcohol, nitrous acid and Ninhydrin. Peptides & peptide bond.

Levels of organizations of Protein: Primary structure, Secondary structure (α-helix, β-pleated structure & triple helix-Collagen), tertiary structure(forces stabilizing tertiary structure) and quaternary structure.

Denaturation and renaturation, Aufinsen's experiment with ribonuclease.

Classification of proteins based on shape, composition and biological function (enzymes, hormones, transport agents, structural & antibodies with examples).

Nucleic acids **3 hours**

Types of nucleic acids, components of nucleic acids, bases, nucleosides and nucleotides. Chargaff's rule of base equivalence. Polynucleotide- partial structure, structure of DNA (Watson-Crick model) and RNA. Biological roles of DNA and RNA. Protein-nucleic acid interaction- chromatin (Histone - nucleic acid interaction) and viral nuclear capsid (Icosahedral virus).

Hormones **2 hours**

Definition. Classification–(i) amino acid derivatives (epinephrine and thyroxine) (ii) peptide (oxytocin and vasopressin) and polypeptide hormones (insulin and glucagon) (iii) Steroid hormones (progesterone, testosterone) with functions. Role of insulin and glucagon in glucose homeostasis. Mediators of hormone action- Ca^{2+} and cyclic AMP.

UNIT-III

Enzymes **4 hours**

Introduction, holoenzyme (apo enzyme and co-enzyme). Active site, specificity (Group, absolute and stereo selectivity with examples).

Classification of enzymes(EC code number not required) with examples.

Enzyme substrate interaction- Fischer and Koshland models.

Enzyme kinetics - factors affecting rate of enzymatic reactions - enzyme concentration, substrate concentration(mention M. M. equation), pH and temperature .

Allosteric enzymes - definition and example

Enzyme inhibitions-Competitive, noncompetitive and uncompetitive inhibition with one example for each.

Biological oxidation **4 hours**

Bioenergetics- Introduction, stages of energy transformation. Exergonic and endergonic reactions. Relationship between ΔG^0 and K_{eq}.

High energy phosphates – definition, examples, structural features of ATP that makes it a high energy phosphate (electrostatic repulsion, opposing resonance, solvation). Examples of high energy phosphates other than ATP (PEP, 1-3-diphosphoglycerate). Energy coupling in biological reactions (explain the concept with suitable examples).

Biological oxidation- comparison of oxidation with combustion using glucose as an example. Redox potentials of some biological important half reactions (NAD^+ and FAD^+). Calculation of energy yield from biological redox reaction (oxidation of NADH by oxygen, reduction of acetaldehyde by NADH). Mitochondrial electron transport chain (schematic representation of electron carriers), oxidative phosphorylation, Substrate level phosphorylation.

Biochemical techniques **2 hours**

Principle and applications of (i) Paper chromatography and TLC (ii) Electrophoresis - cellulose acetate membrane electrophoresis and PAGE (polyacrylamide gel electrophoresis).

UNIT-IV

Metabolism **6 hours**

Catabolism and anabolism: explanation with an example. Carbohydrate metabolism- Glycolysis, fate of pyruvate (Pyruvate to lactate, acetyl CoA, OAA and ethanol). TCA cycle, energetics.

Gluconeogenesis: definition, synthesis of glucose from lactate.

Fatty acid metabolism: activation of fatty acids, role of carnitine, β-oxidation pathway (C_{16}-Palmitic acid), energetics.

Protein metabolism: General aspects of amino acid degradation - transamination, deamination and decarboxylation. Urea cycle.

Molecular biology **4 hours**

Central dogma of molecular biology, semi conservative replication and mechanism of DNA replication, Genetic code: general features. Definition of transcription and translation (mechanism of translation).

DNA finger printing- Definition and its applications.

Allotment of marks in setting the question papers
Chemistry Paper - VIII (Biochemistry) (CBCS)

Note: The questions from Review part should be avoided while setting the semester Question Paper

Sl.No.	Name of the Topic	No. of Hours	Marks
1.	Introduction to biochemistry	02	05
2.	Carbohydrates	04	10
3.	Lipids	04	10
4.	Proteins	05	12-13
5.	Nucleic acids	03	7-8
6.	Hormones	02	05
7.	Enzymes	04	10
8.	Biological oxidation	04	10
9.	Biochemical techniques	02	05
10.	Metabolism	06	15-16
11.	Molecular Biology	04	10
Grand total		40	102

R. VINAYA KUMAR
CHAIRMAN
B.O.E. in Chemistry (UG), 2015-16
Bangalore University
Bengaluru

27/7/16
Prof. L. GOMATHI DEVI
Chairperson, DOS in Chemistry
Bangalore University
Central College City Campus
Bangalore - 560 001.