

Department of Chemistry
St. Joseph's College (Autonomous)

BANGALORE – 27

Structure of the Chemistry Course for B.Sc. Degree

The B.Sc. degree course is a three-year programme divided into six semesters. Each semester will consist of 15 weeks of instruction. In Chemistry there will be 8 Theory papers and 8 Practical papers. Continuous Internal Assessment (CIA) and End Semester Examination (SE) each is given 50% of the weightage in every paper. CIA is based on written tests, seminars, assignments, quiz etc. End Semester theory and Practical examinations will be of 3 hour duration each.

Semester	Code number	Title of the paper	No of hours of instruction	No of hours of teaching per week	Continuous internal assessment (CIA) marks	End Semester Examination marks*	Total marks
I	CH 112	Chemistry-I	60	4	50	50	100
	CH 1P ₁	Practical – I	45	3	35	15	50
II	CH 212	Chemistry-II	60	4	50	50	100
	CH 2P ₁	Practical - II	45	3	35	15	50
III	CH 312	Chemistry-III	60	4	50	50	100
	CH 3P ₁	Practical - III	45	3	35	15	50
IV	CH 412	Chemistry-IV	60	4	50	50	100
	CH 4P ₁	Practical - IV	45	3	35	15	50
V	CH 5112	Chemistry-V	45	3	50	50	100
	CH 5212	Chemistry-VI	45	3	35	15	50
	CH 5P ₁	Practical - V	45	3	50	50	100
	CH 5P ₂	Practical - VI	45	3	35	15	50
VI	CH 6112	Chemistry-VII	45	3	50	50	100
	CH 6212	Chemistry-VIII	45	3	35	15	50
	CH 6P ₁	Practical - VII	45	3	50	50	100
	CH 6P ₂	Practical -VIII	45	3	35	15	50

* The examination will be conducted for 100 marks, which will be reduced to 50 marks.

I SEMESTER

CH112

CHEMISTRY-1

THEORY: 60 HOURS

ATOMIC STRUCTURE

12 Hours

Wave-particle duality, de Broglie equation – derivation & numerical; Heisenberg's uncertainty principle – equation, explanation through thought experiments & numerical; Schrödinger's equation for H atom in Cartesian coordinates, explanation of terms, wave function, Born interpretation; Qualitative explanation of the emergence of quantum numbers, n, l, m, s & problems; Graphical representation of radial distribution of s and p orbitals, shapes of s, p & d orbitals; (n + l) rule, Pauli's exclusion principle, Aufbau principle, Hund's rule; basis of Hund's rule – Exchange energy, pairing energy, symmetrical distribution of charge, promotional energy. Illustration with Cu and Cr. Electronic configuration of elements upto atomic number 36.

PERIODIC TABLE

7 Hours

Historical perspective, Modern periodic law, Long form of the periodic table – periods, groups, s, p, d, f blocks, general electronic configurations, positions of metals, non-metals, metalloids; Atomic radii – covalent, metallic, van der Waal's radii, ionic radii, concept of effective nuclear charge (qualitative treatment only); Trends in atomic radii, trends in ionic radii of isoelectronic ions; Ionisation energy – factors influencing ionization energy, trends in periodic table; Electron affinity – periodic trends; Electronegativity - Pauling scale, numericals, periodic trends.

CHEMICAL BONDING

23 Hours

Ionic bonding: Lattice energy, Born-Lande equation (no derivation), numericals. Born-Haber cycle, numericals (NaCl, KBr, KI, MgO, CaCl₂ type; Explanation of melting point & solubility based on lattice energy; Covalent bonding – Lewis concept, rules for writing Lewis structures, octet rule, formal charge, violations of octet rule. Potential energy diagram for bond formation, orbital overlap s & p; σ & π bonds; VSEPR theory – AB_n type (n ≤ 7) & AB_nL_m type (without π -bonding); Valence bond theory – wave mechanical concept taking H₂ molecule as example, origin of resonance; Resonance energy, resonance structures of simple molecules/ions such as CO₂, CO₃²⁻, CO, SO₄²⁻, O₃; Hybridisation – sp (BeF₂), sp² (BF₃), sp³ (CH₄, H₂O, NH₃), sp³d (PCl₅), sp³d² (SF₆), sp³d³ (IF₇); Molecular orbital theory – qualitative approach, LCAO method,

energy level diagrams of homodiatomic molecules/ions ($Z \leq 9$); heterodiatomic molecules (CO, HF); covalent character of ionic bonding – Fajan’s rules; Non-covalent interactions – Hydrogen bonding (intra & intermolecular type), dipole-dipole, induced dipole-induced dipole interactions, effect on physical properties like melting point and boiling points. metallic bonding – band model, classification into conductors, semi-conductors, insulators based on band gap (n & p type NOT to be discussed).

STOICHIOMETRY

11 Hours

Atomic mass, Avogadro number, gram atomic mass, weight average atomic mass, mole, and molecular mass; Problems based on chemical equations, concept of limiting reagent; Equivalent mass of elements, acids, bases, redox reagents; normality, molarity, molality, and mole fraction; Principles of volumetric analysis.

Problems involving single as well as multiple concepts to be discussed.

IONIC EQUILIBRIA

7 Hours

pH, pOH, $\text{pH} + \text{pOH} = 14$; calculations in aqueous solutions involving strong acids and bases; pK_a , pK_b ; pH calculations involving weak acids/bases; Hydrolysis of salts – salts of strong acid & strong base, weak acid & strong base, strong acid & weak base, weak acid & weak base; derivation of relationship between K_h & K_a/K_b , degree of hydrolysis, effect of temperature & concentration on hydrolysis. Buffers – types, pH of buffers, problems based on Henderson equation.

REFERENCES:

1. Principles of Inorganic Chemistry; B R Puri; L R Sharma and K.C. Kalia; Milestone publishers (2011).
2. Physical chemistry –P.W.Atkins 6th Edition-Oxford University Press (1998).
3. Chemistry; Raymond Chang; (9th Edition) McGraw-Hill Higher Education; (2006).

Further reading

1. Inorganic chemistry; James E. Huheey.
2. Concise inorganic chemistry; J.D Lee 5th Edition.

CH 102

PRACTICAL – 1

11 sessions (3 hrs/week)

1. Concept of errors.
2. Calibration of apparatus and concept of significant figures.

ACID-BASE TITRATIONS

3. Estimation of HCl solution with standard sodium hydroxide using phenolphthalein indicator.
4. Estimation of HCl solution – solid sodium carbonate is provided as primary standard -use

methyl orange indicator.

5. Estimation of sodium hydroxide – solid potassium hydrogen phthalate is provided as primary standard -use phenolphthalein indicator.
6. Application of acid base titration: Determination of acid content of vinegar or wines. Sample preparation done in groups.
7. Estimation of a mixture of sodium carbonate and sodium bicarbonate in a mixture.
8. Estimation of purity of aspirin in the given sample.

REDOX TITRATIONS

9. Estimation of potassium permanganate - Solid sodium oxalate is provided as primary standard.
10. Estimation of potassium bromate – standard potassium dichromate is provided and the link solution is thiosulphate solution.
11. Application of excess back titration: Estimation of ascorbic acid in vitamin C tablets. Sample preparation is done as demonstration and the solution is given – Standard potassium bromate and sodium thiosulphate solutions are given-Use starch as indicator.

PRECIPITATION TITRATION

12. Application of precipitation titration:- Determination of percentage composition of silver in a given sample preparation is explained and the solution is given – Standard sodium chloride is given-Use potassium chromate as indicator.
13. Any other suitable experiments.

REFERENCE:

1. Analytical Chemistry-An introduction; Skoog, West, Holler and Crouch; seventh edition Saunders College Publishing, (1999).
2. Quantitative Analysis (6th Edition); R.A. Day, A.L. Underwood; Prentice Hall; 6 edition (January 14, 1991)
3. Vogel's Quantitative Chemical Analysis (6th Edition); J. Mendham, R.C. Denney, J. D. Barnes, M.J.K. Thomas; Prentice Hall; 6 edition (April 7, 2000)

II SEMESTER

CH 212

CHEMISTRY – II

THEORY: 60 Hours

GASEOUS STATE

6 Hours

Maxwell – Boltzmann distribution law(only equation, no derivation), most probable velocity(C_{mp}), average velocity(C_{av}) and root mean square velocity (C_{rms}), mathematical expressions for C_{mp} , C_{av} and C_{rms} , their relationships and problems. Collision parameters – collision diameter, mean free path, collision number, collision frequency and problems. Andrews experiments on liquefaction of CO_2 , critical constants. Relationship between critical constants and van der Waals constants (no derivation) and problems. Joule – Thomson effect for liquefaction of gases. Joule – Thomson coefficient of gases and inversion temperature.

NUCLEAR CHEMISTRY

6 Hours

Instability of nucleus – n/p ratio, n/p plot, mass defect, binding energy(including problems), binding energy vs mass number plot. Expression for radioactive decay law- logarithmic and exponential forms (no derivation), half –life period, group displacement law, radioactive equilibrium. Radioactive series – first and last nuclide in all four series to be mentioned. Nuclear reactions: nuclear reactions induced by alpha particles, protons, neutrons deuterons and gamma radiation (one example each). Induced radioactivity, applications of radioactive isotopes (in medicine, agriculture, carbon dating and problems on carbon dating).

POLYMER CHEMISTRY

3 Hours

Introduction to polymers; types of polymers; number average and weight average molecular weights of polymers. Determination of molecular weights of polymers by viscosity and light scattering methods.

ACIDS AND BASES

5 Hours

Concept of Lowry and Bronsted – conjugate acid base pairs. Lewis concept Solvent system concept, Hard and Soft acid – base theory and its applications.

NON AQUEOUS SOLVENTS

5 Hours

Classification of solvents, characteristic properties of solvents – liquid range and dielectric constants. Levelling effect. Liquid ammonia – acid –base and precipitation reactions, solutions of metals in liquid ammonia, limitations of liquid ammonia. Liquid HF and liquid SO_2 – acid –base and precipitation reactions.

IONIC CRYSTALS**5 Hours**

Close packing and radius ratio rules. Structures of ionic compounds of the type AX and AX₂ (NaCl, CsCl, zinc blende, Wurtzite, Fluorite – CaF₂ and antiferite - K₂O). antiferite).

FIRST LAW OF THERMODYNAMICS**8 Hours**

Introduction- terminology in thermodynamics-phase, system and surroundings.

Types of systems - open, closed and isolated systems; homogeneous and heterogeneous systems, macroscopic properties. State of a system, state variables, extensive and intensive properties, thermodynamic equilibrium. Thermodynamic processes-isothermal, adiabatic, isochoric, isobaric and cyclic. Reversible, irreversible and spontaneous processes. Concept of heat and work-sign convention, state functions and path functions, exact and inexact differentials. Internal energy, I law of thermodynamics-statement and mathematical form, enthalpy of a system, heat capacity, relation between c_p and c_v . Expression for I law of thermodynamics for isothermal, adiabatic, isobaric, isochoric and cyclic processes. Work done in i) irreversible expansion and compression of an ideal gas, ii) reversible isothermal expansion and compression of an ideal gas. Zeroth law and absolute temperature scale. Kirchoff's law (derivation).

CHEMICAL KINETICS**7 Hours**

Review of chemical kinetics. [definitions of rate of a reaction, order, molecularity, rate constant, rate equation or law, half life]. Derivation of rate expressions for a 2nd order reaction when $a = b$ and $a \neq b$. Experimental methods of studying kinetics of reactions- Principles of volumetric method [saponification of ester] and colorimetric method [iodination of acetone]. Methods of calculation of order of a reaction – i) integral and graphical method, ii) Half life period method [$t_{1/2}$ for nth order to be derived].. Effect of Temperature on reaction rates -Temperature coefficient. Arrhenius theory, concept of energy barrier. Bimolecular collision theory - [final equation given, no derivation]. Limitations of bimolecular collision theory. Transition state theory – qualitative approach. Steady state approximation, Lindemann theory - kinetics of unimolecular reactions.

INTRODUCTION TO ORGANIC CHEMISTRY**11 Hours**

Classification of reactions and reagents; inductive effect, resonance and steric effects; reactive intermediates. IUPAC nomenclature of monofunctional and bifunctional organic compounds.

ALKANES**4 Hours**

Physical properties – boiling and melting points, solubility; Reaction with halogens. Mechanism of chlorination of methane. Halogenation of higher alkanes – selectivity of bromine.

REFERENCES:

1. Principles of Physical Chemistry ; B R Puri; L R Sharma and M B Pathania (43rd edition); Vishal Chand Publishing Co.; (2008).
2. Principles of Inorganic Chemistry; B R Puri; L R Sharma and K.C. Kalia; Vallabh Publications; (2005).
3. Chemistry; Raymond Chang; (Ninth Edition); MaGraw-Hill Higher Education; (2006).
4. Atkins' Physical Chemistry; Peter Atkins and Julio de Paula; (Seventh Edition).; Oxford University Press; (2002).
5. Thermodynamics for Students of Chemistry; Kuriacose and Rajaram; Shoban Lal Nagin Chand and Co. (1996).
6. Text Book of Physical Chemistry; Samuel Glasstone; Macmillan India Ltd.
7. Organic Chemistry, T. W. G. Solomons, C.B. Fryhle (9th Edition) Willy India, (2008).
8. Organic Chemistry, R.T. Morrison and R.N. Boyd, (6th Edition), Printice Hall, (1992).
9. Organic Chemistry, Volume 1, I.L. Finar,(6th Edition), ELBS, Longman, (1973).
10. Organic Chemistry, Volume 2, I.L. Finar,(5th Edition), ELBS, Longman, (1975).

CH 2P₁

PRACTICAL – 2

11 sessions (3 hrs/week)

1. Laboratory safety procedures. Introduction to different types of glassware. Handling and cleaning of apparatus.
2. Methods of Separation and Purification
Crystallization, distillation, fractional distillation, steam distillation, sublimation, determination of melting point and boiling point; chromatography – thin layer and column chromatography
3. Preparation of organic compounds:
 - (a) Acetylation – preparation of acetanilide and aspirin
 - (b) Nitration – preparation of m-dinitrobenzene and p-nitroacetanilide
 - (c) Halogenation – preparation of p-bromoacetanilide and 2,4,6-tribromophenol
 - (d) Oxidation – preparation of benzoic acid from benzaldehyde
 - (e) Reduction – preparation of aniline from nitrobenzene
 - (f) Hydrolysis – preparation of p-bromoaniline from p-bromoacetanilide
4. Determination of equivalent weight of a carboxylic acid.
5. Estimation of phenol.
6. Estimation of nitro group.

III SEMESTER

CH 312

CHEMISTRY – 3

THEORY: 60 Hours

CHEMISTRY OF REPRESENTATIVE ELEMENTS – 1

15 Hours

Gradation in properties and comparative study of properties to be emphasized.

Group 1 – Alkali Metals:

4 Hours

Electronic configuration, oxidation state, melting points and boiling points, densities, metallic character, nature of bonds formed, photoelectric effect, hydration of ions and ionic conductance in solution, flame colouration. Reactivity, electrode potentials and reducing properties, reaction with water, complexes with crown ethers and cryptands. Compounds: Oxides, peroxides, superoxides – their reaction with water, importance of superoxides. Hydroxides – basic character and stability. Halides – solubility and crystal structure. Carbonates – thermal stability, solubility and hydrolysis. Bicarbonates – stability. Hydrides – reaction with water, complex hydrides. Unique properties of lithium and its diagonal relationship with magnesium.

Group 2 – Alkaline earth Metals:

3 Hours

Electronic configuration, oxidation state, melting points and boiling points, densities, metallic character, nature of bonds formed, flame colouration. Reactivity, electrode potentials and reducing properties, reaction with water.

Compounds: Oxides and peroxides, basic character of oxides and hydroxides. Halides – solubility, structure of beryllium chloride. Sulphates – solubility. Carbonates and bicarbonates – thermal stability. Hydrides – structure of beryllium hydride.(the characteristics of alkali metals and alkaline earth metals to be compared wherever required).

CHEMISTRY OF p – BLOCK ELEMENTS – I

Group 13 – Boron Group:

5 Hours

Electronic configuration, oxidation states, inert pair effect, metallic character, nature of bonds formed, basic character of oxides and hydroxides. Compounds; Hydrides – classification of boron hydrides, diborane – preparation – preparation (from BCl_3), properties (reactions with ammonia and Lewis acid properties) and structure (based on VBT). Halides – boron trifluoride – preparation(from B_2O_3), properties (Lewis acid properties and hydrolysis) and structure (based on VBT), comparison of Lewis acid character of boron trihalides, structure of aluminium

chloride, differences in the structures of trihalides of B and Al. Borazine – preparation, properties (addition of HCl) and structure.

Group 14 – Carbon Group:

3 Hours

Electronic configuration, oxidation states; inert pair effect, metallic character, nature of bonds formed, catenation, allotropic forms of carbon and their structures, fullerenes, C – 60, and carbon nanotubes (brief mention without structural details).

Compounds Tetrahalides – behaviour towards hydrolysis. Oxides – basic character of the dioxides, structures of CO₂ and SiO₂. Carbides – salt – like, covalent and interstitial. Silicates – classification, structures of ortho and pyrosilicates.

SECOND LAW OF THERMODYNAMICS

15 Hours

Limitations of I law, scope of II law, Statements of II law of thermodynamics (to be introduced wherever the concepts arise). Spontaneous and non-spontaneous processes, spontaneity and equilibrium. Driving force for spontaneous processes. Concept of entropy and its physical significance. Entropy change in adiabatic and isothermal reversible expansions of an ideal gas. Change in entropy of an ideal gas with change in P, V and T (derivation of equation) – modified equation for isothermal, isochoric and isobaric processes. Entropy of phase change. Entropy changes in the system and surroundings in an isothermal reversible expansion and isothermal irreversible expansion of an ideal gas, entropy criteria for spontaneity, Carnot cycle – derivation of efficiency based on entropy concept. Relation between entropy and probability,

III law of thermodynamics – determination of absolute entropies of substances, standard entropies, residual entropy.

Free energy – Gibb's free energy & Helmholtz free energy (work function), Relation between w and ΔA , w and ΔG , standard free energy change of a reaction. Free energy criteria of spontaneity, variation of G with T and P . Gibb's Helmholtz equation – derivation. Relation between free energy & equilibrium constant of a reaction.

Clausius–Clapeyron equation–derivation, application to liquid-vapour and solid-liquid equilibria,.

STEREOCHEMISTRY

14 Hours

Constitutional isomers and stereoisomers; enantiomers and chiral molecules; test for chirality; R and S system of nomenclature of enantiomers ; properties of enantiomers; optical activity; racemic forms; molecules with more than one chiral centre; meso compounds; naming compounds with more than one chirality centre. Fischer projection formulae; resolution using amines as resolving agents. Chiral molecules that do not possess chiral centre – allene derivatives. Geometrical isomerism – E,Z nomenclature.

Sigma bonds and bond rotation; conformational analysis of ethane and butane; relative stabilities of cycloalkanes; ring strain; origin of ring strain in cyclopropane and cyclobutane; angle strain.

ALKYL HALIDES

8 Hours

Nucleophilic substitution reactions; nucleophiles; leaving groups; kinetics of a nucleophilic substitution reaction. S_N2 reaction and its mechanism. Transition state theory – free energy diagrams. Stereochemistry of S_N2 reaction. S_N1 reaction and its mechanism. Stereochemistry of S_N1 reaction. Factors affecting rates of S_N1 and S_N2 reactions. Nucleophilic substitution reactions in organic synthesis – functional group transformations using S_N2 reaction. Elimination reactions of alkyl halides; E2 and E1 reactions. Substitution versus elimination.

ALKENES AND ALKYNES-I

8 Hours

Relative stabilities of alkenes, explanation using heat of hydrogenation data. Synthesis of alkenes from alkyl halides, Zaitsev's rule, exception to the rule when bulky base is used; acid catalysed dehydration of alcohols, carbocation stability and rearrangements.

Synthesis of alkynes by elimination reactions of vicinal dibromide and geminal dihalides, Acidity of terminal alkynes. Alkylation of terminal alkynes.

Reactions of Alkenes: hydrogenation of alkenes - syn and anti addition, electrophilic addition of hydrogen halides to alkenes: mechanism and Markovnikov's rule, regioselective reactions, exception to Markovnikov's rule.

REFERENCES:

1. Principles of Physical Chemistry, B R Puri; L R Sharma and M B Pathania (43rd edition); Vishal Chand Publishing Co. (2008).
2. Text Book of Physical Chemistry- P L Soni, O.P Dharmarha and U N Dash; Sultan Chand and Sons; (2006)..
3. Thermodynamics for Students of Chemistry; Kuriacose and Rajaram; Shoban Lal Nagin Chand and Co. (1996).
4. Physical Chemistry through problems; S K Dogra and S Dogra; New Age International (P) Ltd. Publishers; (2004).
5. Organic Chemistry, T. W. G. Solomons, C.B. Fryhle (9th Edition) Willy India, (2008).
6. Organic Chemistry, R.T. Morrison and R.N. Boyd, (6th Edition), Printice Hall, (1992).
7. Organic Chemistry, Volume 1, I.L. Finar,(6th Edition), ELBS, Longman, (1973).
8. Organic Chemistry, Volume 2, I.L. Finar,(5th Edition), ELBS, Longman, (1975).
9. Principles of Inorganic Chemistry, B.R.Puri, L.R.Sharma and K.C.Kalia, Vallabh Publications, (2005).

10. Concise Inorganic Chemistry 5th edition, J.D.Lee, Blackwell Science, (1996).

CH 3P₁

PRACTICALS – III

11 sessions (3 hrs/week)

1. Concept of common ion effect and solubility product
2. Application of above concepts in salt analysis
3. Semimicro qualitative analysis of inorganic salt mixtures.

IV SEMESTER

CH 412

CHEMISTRY – IV

THEORY: 60 Hours

CATALYSIS

6 Hours

Catalysis- general characteristics of catalytic reactions, catalytic poisons, catalytic promoters, positive and negative catalysts, auto catalysis, working of a catalyst (using a plot of energy vs reaction coordinate). Types of catalysis – Homogeneous and heterogeneous catalysis with examples, kinetics and mechanism of acid catalysed reactions, derivation of rate expression for general and specific acid catalysed reactions only. Theories of catalysis – Intermediate complex theory (generally for homogeneous catalysis), adsorption theory (for heterogeneous catalysis). Industrial applications of catalysis .

CHEMISTRY OF REPRESENTATIVE ELEMENTS – II

7 Hours

CHEMISTRY OF p – BLOCK ELEMENTS - II

Group 15 – Nitrogen Family

Electronic configuration, oxidation state, metallic character and physical state. Compounds: oxides and oxyacids of nitrogen and phosphorus- structures only (nitrous oxide, nitric oxide, nitrogen dioxide, phosphorus trioxide, phosphorus pentoxide, nitrous acid, nitric acid, meta-,ortho- and pyrophosphoric acids).

Group 16 – Oxygen Family

Electronic configuration, oxidation state, metallic character and physical state. Oxyacids of sulphur – structures only (sulphurous acid, sulphuric acid, Caro's and Marshall's acids)

Group 17 – Halogen Family

Electronic configuration, oxidation state, metallic character and physical state. Oxidising power of halogens. Hydrides –relative strengths of acids (based on Born- Haber cycle). Oxides and oxyacids – structures only(chlorous, chloric and perchloric acids and their anhydrides). Interhalogen compounds – examples and structures (ClF_3 , BrF_5 , IF_7).

Group 18 – Noble Gases: Compounds of noble gases – Bartlett experiment, structures of fluorides and oxides – discussion using concept of hybridization (XeF_2 , XeF_4 , XeF_6 , XeO_3 , XeO_3F_2).

INORGANIC MATERIALS

7 Hours

Glass – composition, raw materials, varieties of glass – borosilicate, optical and safety glass – composition and uses.

Refractories – classification, properties – refractoriness, resistance to spalling.

Abrasives – classification(natural and synthetic) with examples. Hardness of abrasives.

Cement – Composition, raw materials, setting of cement.

Nanomaterials – Nanodomain, types of nanomaterials, synthesis – top- down and bottom – up fabrication. Application of inorganic nanomaterials. Zeolites – Chemical composition, building blocks, properties – adsorption, ion – exchange ,catalytic properties.

LIQUID MIXTURES

6 Hours

Raoult's Law, mathematical formulation, vapour pressure curves of ideal solutions, vapour pressure curves of non ideal Solution (All three types are to be discussed).

Vapour pressure curves of completely miscible liquids. Boiling point - composition curves of completely miscible liquids. Fractional distillation of binary liquid solutions.

Type II and Type III azeotropic mixtures (Minimum boiling and maximum boiling Azeotropes) [Eg. Water ethanol and HCl-H₂O respectively to be discussed.]

Solubility of partially miscible liquid pairs; upper CST: Phenol-H₂O system. Lower CST: triethylamine-H₂O System; lower CST & upper CST: nicotine amine-water system. Effect of impurity on CST. Nernst distribution law, Application in the case of Association and Dissociation.

QUANTUM MECHANICS

6 Hours

. Max Planck's quantum theory of radiation, photoelectric effect. Concept of Operator- examples (position, momentum, kinetic energy, potential energy and Laplacian operators). Postulates of quantum mechanics (four postulates).

Particle in one dimensional box. Derivation of expression for energy, normalization of wave function, quantization of energy states. Particle in a three dimensional box, degeneracy of energy states.

SPECTROSCOPY-THEORETICAL CONCEPTS

12 Hours

Electromagnetic radiation (EMR)- Characteristics – Frequency, wavelength and wave number and mathematical expressions connecting them. Types of Spectra: (Atomic and molecular). Absorption and emission spectra: continuous, band and line. Regions of electromagnetic spectrum. Processes and spectral techniques associated with different regions. Different types of Molecular spectra i) Rotational (ii) vibrational and vibrational - rotational iii) Electronic (UV & visible). Born Oppenheimer approximation. $E_{tot} = E_{rot} + E_{vib} + E_{el}$. Rotational Spectra of diatomic molecules: Rigid rotor model. Final expression for moment of inertia $I = \mu r^2$

and its significance. Calculation of reduced mass. Expression for rotational energy in terms of joule and cm^{-1} ; $E_J = \frac{h^2}{8\pi^2 I} [J(J+1)]$ joule and in cm^{-1} E_J / hc . Expression for rotational constant; selection rule (gross and quantum selection rules) $\Delta J = \pm 1$. Energy level diagram for a rigid rotor and rotational spectrum. Vibrational Spectra of diatomic molecule. Hooke's Law. Oscillator frequency of Simple Harmonic Oscillator. Mathematical equation for fundamental vibrational frequency and fundamental wave number in terms of force constant, significance of force constant, effect of reduced mass on vibrational frequency. Equation relating wave number and force constant. Potential energy curve for a diatomic molecule of a harmonic oscillator. Selection rule. $\Delta v = \pm 1$. Energy level diagram. Expression for vibrational energy and Zero point energy. Fundamental vibrations, total degrees of freedom (translational, rotational and vibrational) for linear and non linear molecules. Calculation of fundamental vibrations for linear and non linear molecules (E.g. H_2O , CO_2). Schematic representation of fundamental vibrations for H_2O , CO_2 and their IR activity. Raman spectra – elastic and inelastic collisions, Raleigh and Raman scattering. Raman shift, Stokes and anti Stokes lines, intensity of Stokes and anti Stokes lines, rule of mutual exclusion, difference between IR and Raman spectroscopy.

ALKENES AND ALKYNES-II

8 Hours

Stereochemistry of ionic addition to alkenes, addition of water to alkenes: acid-catalysed hydration, mechanism, alcohols from alkenes through oxymercuration–demercuration reaction and hydroboration–oxidation and their regioselectivity. Electrophilic addition of bromine and chlorine to alkenes – stereochemistry. Halohydrin formation. Oxidation of Alkenes: syn 1,2-dihydroxylation. Cleavage of alkenes with hot basic potassium permanganate and with ozone.

ALCOHOLS AND ETHERS, EPOXIDES

3 Hours

Acidity of alcohols; conversion of alcohols into alkyl halides.

Synthesis of ethers (no mechanism); Williamson ether synthesis. Reactions of ethers: Cleavage of ethers.

Epoxides: epoxidation (no mechanism). Reactions of epoxides: mechanism of acid catalysed formation of anti 1,2 diol; regioselectivity.

ORGANOMETALLIC COMPOUNDS

2 Hours

Preparation of organolithium and organomagnesium compounds. Use of organolithium reagents in synthesis.

CONJUGATED SYSTEMS

3 Hours

1,3-butadiene: electron delocalization, MO explanation. 1,4 addition - kinetic versus thermodynamic control. Diels-Alder reaction.

REFERENCES:

1. Principles of Physical Chemistry ; B R Puri; L R Sharma and M B Pathania (43rd edition); Vishal Chand Publishing Co.; (2008).
2. Fundamentals of Molecular Spectroscopy; Colin N Banwell and Elaine M McCash; [Fourth edition (14th Reprint)]; Tata McGraw-Hill Publishing Company Limited, (2004).
3. Introduction to Quantum Chemistry; A K Chandra; (Fourth Edition); Tata McGraw-Hill Publishing Company Ltd.
4. Physical Chemistry; P W Atkins; (Sixth edition); Oxford University Press; (1998).
5. Text Book of Physical Chemistry; Samuel Glasstone; Mac Millan India Ltd.
6. Principles of Inorganic Chemistry; B R Puri; L R Sharma and K.C. Kalia; Vallabh Publications; (2005).
7. Physical Chemistry; Robert A Alberty and Robert J Silbey; (First Edition); John Wiley and Sons, Inc. (1995).
8. Organic Chemistry, T. W. G. Solomons, C.B. Fryhle (9th Edition) Willy India, (2008).
9. Organic Chemistry, R.T. Morrison and R.N. Boyd, (6th Edition), Printice Hall, (1992).
10. Organic Chemistry, Volume 1, I.L. Finar, (6th Edition), ELBS, Longman, (1973).
11. Organic Chemistry, Volume 2, I.L. Finar, (5th Edition), ELBS, Longman, (1975).

CH 4P₁

PRACTICALS – IV

11 sessions (3 hrs/week)

1. Determination of density and viscosity of a given liquid using Ostwald's viscometer.
2. Determination of percentage composition of a binary mixture by viscosity method.
3. Determination of CST of phenol- water system.
4. To show that the saponification of ethyl acetate follows second order kinetics and to determine its rate constant at room temperature.
5. Determination of molecular diameter by surface tension measurement using a stalagmometer.
6. Determination of percentage composition of sodium chloride solution by miscibility temperature measurements of phenol – water system.
7. Determination of transition temperature of a salt hydrate by thermometric method.
8. Determination of the order of the reaction in iodine for the acid catalysed iodination of acetone by colorimetric method
9. Determination of the rate constant of the saponification of an ester by conductometric method.
10. Determination of CST of aniline water system.
11. Determination of the distribution coefficient of succinic acid between ether and water.

12. Determination of the distribution coefficient of iodine between CCl_4 and water.
13. To study the adsorption of a solute (acetic acid) on a dispersed solid (activated charcoal).
14. To study the adsorption of oxalic acid on activated charcoal.
15. To compare cleansing powers of two samples of detergents by surface tension method.
16. To determine the percentage composition of a given mixture of two liquids by surface tension method.
17. To determine critical micelle concentration from surface tension measurements.
18. Molecular weight of a polymer by viscosity method.
19. Any other suitable experiment relevant to the syllabus.

REFERENCES:

1. University Practical Chemistry, P C Kamboj; Vishal Publishing Co, (2008).
2. Advanced Practical Physical Chemistry; J B Yadav; Goel Publishing House Meerut; (2007).
3. Practical Physical Chemistry; B Vishwanathan, P.S. Raghavan; Viva Books Pvt. Ltd.; New Delhi (2009).

V SEMESTER

CH 5112

PHYSICAL CHEMISTRY

THEORY: 45 Hours

ELECTROCHEMISTRY

25 Hours

Brief introduction to electrochemistry. Conductance, specific conductance, cell constant, equivalent conductance, molar conductance – Definitions and expressions. Only in SI units. Determination of molar conductance of a strong electrolyte (λ_c). Relationship between molar conductance and equivalent conductance. Variation of specific conductance and equivalent conductance with concentration. Conductance at infinite dilution, degree of dissociation, classification of electrolytes.

Kohlrausch's law of independent migration of ions, application of Kohlrausch's law to determine molar conductance at infinite dilution and degree of dissociation.

Transport number, its relationship with ionic conductance and mobility of ions. Causes of abnormal transport numbers observed in certain systems (Eg., Cd in CdI_2 .) transport numbers of alkali metal ions – to be discussed w.r.t degree of hydration). Abnormal conductivities of H^+ and OH^- ions.

Conductometric titrations- Acid base (strong acid-strong base, weak acid-strong base, strong acid-weak base, weak acid weak base). Advantages of conductometric titrations.

Limitations of Arrhenius theory; Theory of strong electrolytes – Qualitative account of Debye-Huckel theory (asymmetry effect and electrophoretic effect). Debye-Huckel-Onsagar(DHO) equation for aqueous solutions of 1:1 electrolytes (Derivation is not included, to be assumed), Verification of DHO equation.

Electrochemical cells: (electrolytic and Galvanic cells). Concept of conversion of chemical energy into electrical energy using ionic equations. Concept of anode and cathode; Redox potentials - standard potentials, standard cell - Weston cadmium cell, its advantages (excluding construction of Weston cadmium cell). Construction of Galvanic Cells - Daniel cell; EMF of a cell. Schematic representation of Galvanic cells. Reversible and irreversible cells, types of electrodes, liquid junction potential. Thermodynamic deduction of Nernst equation (cell as well as single electrode)- SHE - construction, working and limitations. Types of electrodes.

Reference electrodes – Calomel electrode, quinhydrone electrode, determination of pH using quinhydrone electrode. The electro chemical series-Important generalizations from electrochemical series.

Potentiometric titration – principle and applications (redox titration).

PHOTOCHEMISTRY

8 Hours

Introduction to photochemistry, Photo physical and photochemical processes. Difference between thermal and photochemical reactions. Laws of photochemistry. Consequences of absorption of light radiation- Luminescence, Fluorescence, Phosphorescence; singlet and triplet states; Explanation for Fluorescence, Phosphorescence with the help of Jablonski diagram, Chemiluminescence. Energy absorbed /mol (Einstein) Beer Lamberts law - derivation of $A = \epsilon cx$. Application to colorimetry (determination of unknown concentration from the calibration curve) Quantum efficiency Φ ; Study of the following photochemical reactions: i) between H_2 and Cl_2 ii) between H_2 and Br_2 . iii) Photochemical decomposition of HI in gaseous phase and iv) dimerisation of anthracene [discussion on mechanism for (i) to (iv)]. Photosensitization; (E.g.: Decomposition of H_2 in the presence of Hg vapour, Chlorophyll as sensitizer, decomposition of oxalic acid in solution in the presence of uranyl ions), Bioluminescence.

PHASE EQUILIBRIUM

6 Hours

Meaning of the terms- phase, component and degrees of freedom. Discussion with examples and reasoning. Gibbs Phase rule (derivation not included). Application of phase rule to one component systems- water system. Effect of P & T on triple point of water.

Application of phase rule to two component systems, two component solid-liquid systems, reduced phase rule for condensed systems, Two component alloy system, Eutectic system - Pb – Ag system, Pattinson's process of desilverisation of Pb. KI- H_2O System. Freezing mixtures.

SOLID STATE CHEMISTRY

6 Hours

Differences between crystalline and amorphous solids – Isotropy and anisotropy with respect to light. Interfacial angles. Symmetry in cubic systems- 23 elements of symmetry (must be explained); Space lattice and unit cell. Bravais lattices, 7 crystal systems, 14 space lattices, law of rational indices. Miller indices; Derivation of Bragg's equation, equation for interplanar spacing only for cubic crystal system. X-Ray diffraction- Experimental determination of structure by rotating crystal method e.g. NaCl and KCl.

REFERENCES:

1. Principles of Physical Chemistry; B R Puri; L R Sharma and M B Pathania (43rd edition); Vishal Chand Publishing Co. (2008).
2. Inorganic Chemistry; Shriver and Atkins; (Fourth Edition); Oxford University Press.
3. Photochemistry; Gurdeep Raj; Goel Publishing House Meerut

4. An Introduction to Electrochemistry; Samuel Glasstone, East – West Press Pvt Ltd. New Delhi- (2009)
5. Atkins' Physical Chemistry; Peter Atkins and Julio de Paula; (Seventh Edition); Oxford University Press; (2002).
6. Physical Chemistry through problems; S K Dogra and S Dogra; New Age International (P) Ltd Publishers (2004).

ARENES**7 Hours**

Kekule structure and stability of benzene based on heats of hydrogenation. Theories of structure of benzene - resonance explanation, molecular orbital explanation (energy level diagram, without shapes of orbitals). Huckel's rule. Antiaromatic, nonaromatic species - benzenoid and heterocyclic aromatic compounds. Electrophilic aromatic substitution reaction, general mechanism (energy profile to be given). Nitration, sulphonation, halogenation, Friedel Craft's alkylation and acylation reactions. Reactivity and orientation: o-, p-, m- directors, activators and deactivators. Orientation in toluene, phenol, chlorobenzene and nitrobenzene. Side chain halogenation; oxidation of side chain.

ALDEHYDES AND KETONES**9****Hours**

Synthesis of aldehydes by the oxidation of primary alcohols and by the reduction of acyl chloride, esters and nitriles. Synthesis of ketones by ozonolysis, oxidation of secondary alcohols, Friedel Craft's reaction and using Grignard reagent. Nucleophilic addition to carbonyl compounds: Mechanism of addition using strong nucleophiles and acid catalyzed nucleophilic addition. Relative reactivity of aldehydes versus ketones. Addition of alcohols. Mechanism of acid catalysed acetal formation. Addition of amines (primary and secondary amines, hydrazine and hydroxylamine). Addition of HCN - mechanism. Wittig reaction (no mechanism, only a few examples). Oxidation of aldehydes and ketones. Acidity of α -Hydrogen, enolate ion. Keto- enol tautomerism. Base catalysed aldol reaction, dehydration of aldol product (mechanism of both), crossed aldol reaction (practical crossed aldol reactions). Claisen-Schmidt reaction (no mechanism). Cyclisation via aldol reaction. Addition to α,β -unsaturated aldehydes and ketones (no mechanism). Michael addition (no mechanism)

CARBOXYLIC ACIDS AND DERIVATIVES**5 Hours**

Acidity of carboxylic acids. Preparation of carboxylic acids by the oxidation of aldehydes and primary alcohols, hydrolysis of cyanohydrins, nitriles and by carbonation of Grignard reagents. Nucleophilic substitution at the carboxylic carbon- General mechanism. Relative reactivity of acid derivatives.

β - Dicarbonyl compounds: Introduction, acidity, Claisen condensation with mechanism, crossed Claisen condensation. Acetoacetic ester synthesis – Alkylation and acylation. Malonic ester synthesis – alkylation. Knoevenagel condensation (no mechanism).

AMINES

5 Hours

Basicity of alkyl and aryl amines. Preparation of amines- Gabriel's phthalimide reaction, reduction of nitro compounds, reductive amination, reduction of nitriles, oximes and amides, Hofmann rearrangement. Reaction of 1^o, 2^o and 3^oalkyl and arylamines with HNO₂. Replacement reactions of aryl diazonium salts. Hofmann elimination.

SPECTROSCOPY

9 Hours

UV-vis spectroscopy: Types of electronic transitions in organic molecules, observed transitions in typical UV-vis spectrum, effect of conjugation on λ_{max} .

IR spectroscopy: Characteristic group frequencies, IR spectra of hydrocarbons and hetero atom containing functional groups

NMR spectroscopy: Instrumentation, Nuclear spin, deshielding, shielding, Equivalent and nonequivalent protons, chemical shift, integration of signal area, spin-spin coupling, interpretation of NMR spectra. Rate processes.

CARBOHYDRATES

6 Hours

Classification of carbohydrates, classification of monosaccharides, structures of monosaccharides (glucose in detail). Mutarotation, glycoside formation (O-methylation). Oxidation of monosaccharides (using Benedict's and Tollen's reagents) – concept of reducing sugars. Bromine water oxidation, nitric acid oxidation. Reduction of monosaccharides, osazone formation. Synthesis and degradation of monosaccharides (Kiliani-Fischer synthesis and Ruff degradation). Disaccharides: sucrose, maltose, cellobiose (structures only).

NATURAL PRODUCTS

4 Hours

Terpenes: Introduction, isoprene rule, classification. Structure and synthesis of Citral.

Alkaloids: Introduction, general properties, Structure and synthesis of nicotine.

REFERENCES:

1. Organic Chemistry, T. W. G. Solomons, C.B. Fryhle (9th Edition) Wiley India, (2008).
2. Organic Chemistry, R.T. Morrison and R.N. Boyd, (6th Edition), Printice Hall, (1992).
3. Organic Chemistry, Volume 1, I.L. Finar,(6th Edition), ELBS, Longman, (1973).
4. Organic Chemistry, Volume 2, I.L. Finar,(5th Edition), ELBS, Longman, (1975).
5. Applications of Absorption spectroscopy of Organic Compounds, J.R.Dyer (6th Reprint), Printice Hall, (1987).
6. Organic Chemistry, P. Y. Bruice, (3rd Edition), Pearson Education, (2008).

CH 5P₁

PRACTICAL-V

11 sessions (3 hrs/week)

- 1 Estimation of the amount of sodium hydroxide present in the given solution using approximately normal hydrochloric acid by conductometric titration.
- 2 Estimation of the amount of weak acid present in the given solution using approximately normal solution of sodium hydroxide by conductometric titration.
- 3 To determine the amount of ammonium hydroxide in the given solution using approximately normal solution of hydrochloride solution by conductometric titration.
- 4 Determination of equivalent conductance of a strong electrolyte
- 5 Potentiometric titration of potassium iodide against potassium permanganate.
- 6 To determine pK_a of a weak acid by titrating it against a strong base potentiometrically.
- 7 Estimation of potassium dichromate using ferrous ammonium sulphate by potentiometric titration.
- 8 To verify Beer-Lambert law and to estimate the amount of iron present in the given solution by colorimetric method.
- 9 To estimate the amount of copper present in the given solution by colorimetric method.
- 10 Determination of Solubility of sparingly soluble salt (BaSO₄) by conductometry
- 11 Determination of Standard Electrode Potential of Zn / Cu
- 12 Determination of pH using quinhydrone electrode.
- 13 To show that the acid hydrolysis of methyl acetate is of first order kinetics and to determine the rate constant at room temperature.
- 14 Kinetics of reaction between KI and persulphate.
- 15 Experiments pertaining to Phase diagram
- 16 Any other experiment relevant to the syllabus.

REFERENCES:

1. University Practical Chemistry, P C Kamboj; Vishal Publishing Co, 2008.
2. Advanced Practcal Physical Chemistry; J B Yadav; Goel Publishing House Meerut; 2007.

CH 5P₂**PRACTICAL- VI****11 sessions (3 hrs/week)****QUALITATIVE ORGANIC ANALYSIS:**

Analysis of simple organic compounds containing one functional group (9 sessions).

Structure determination of simple organic compounds from spectral data (UV, IR and PMR).
(2 sessions)

REFERENCE:

1. Textbook of Practical Organic Chemistry, A I Vogel (1996).

VI SEMESTER

CH 6112

INORGANIC CHEMISTRY

THEORY: 45 Hours

d – BLOCK ELEMENTS AND COORDINATION CHEMISTRY

23 Hours

Electronic configuration of first row transition elements, characteristic properties – oxidation states, colour, magnetic properties, catalytic property, interstitial compound formation and complex formation. Introduction to coordination chemistry, terminology, types of ligands, IUPAC nomenclature, Werner's theory – explanation of the postulates using cobalt – ammine complexes. EAN rule. Geometries of complexes with coordination number ranging from 2 to 6 with examples. Isomerism – structural and stereoisomerism. Theories of bonding: Valence Bond Theory as applied to 4 and 6 coordinate complexes, inner and outer orbital complexes, limitations of VBT. Crystal Field Theory: for octahedral, tetrahedral and square planar complexes. Factors affecting $10Dq$, spectrochemical series, CFSE, magnetic properties, colour, electronic spectra (d^1 system only), limitations of CFT.

ORGANOMETALLIC CHEMISTRY

6 Hours

Introduction, classification of Organometallic compounds based on bond type, classification of ligands based on hapticity, structures of $Ni(CO)_4$, $Fe(CO)_5$, $Cr(CO)_6$, $Co_2(CO)_8$, $Mn_2(CO)_{10}$, $Fe(C_5H_5)_2$, $Cr(C_6H_6)_2$, $K[PtCl_3(C_2H_4)]$, $W(CH_3)_6$. 18 – electron rule, illustration of the rule using the above examples. Bonding in metal carbonyls – qualitative approach. Organometallic compounds in catalysis – Ziegler – Natta polymerization of ethylene, alkene hydrogenation using Wilkinson's catalyst and Monsanto acetic acid process.

BIO – INORGANIC CHEMISTRY

4 Hours

Role of metal ions in biological systems, metalloporphyrins – haemoglobin and myoglobin in oxygen transport and storage, difference in the binding characteristics of haemoglobin and myoglobin towards oxygen, phenomenon of cooperativity and its mechanism.

f – BLOCK ELEMENTS

6 Hours

The lanthanide series – introduction, electronic configuration, oxidation states, atomic and ionic radii – lanthanide contraction and its consequences, colour, magnetic properties and complex formation. Extraction of lanthanides from monazite, separation by ion exchange method. Comparison of the lanthanides with the transition elements with respect to their oxidation states, magnetic properties, electronic spectra and complex formation.

Actinide series: General electronic configuration, oxidation states.

OXIDATION and REDUCTION

6 Hours

Latimer diagrams, Frost diagrams, Pourbaix diagrams and their applications.

REFERENCES:

1. Principles of Inorganic Chemistry, B.R.Puri, L.R.Sharma and K.C.Kalia, Vallabh Publications, (2005).
2. Concise Inorganic Chemistry 5th edition, J.D.Lee, Blackwell Science, (1996).
3. Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, ELBS, (1989).

CH 6212

BIOCHEMISTRY

THEORY: 45 Hours

INTRODUCTION TO BIOCHEMISTRY

2 Hours

Introduction to biochemistry. Elemental and molecular composition of biological systems. Criteria for selection of elements according to their biological role (CHNOPS). Different types of interactions occurring in the biological system, Properties and role of water in the biological system. Overview of major functions of cell organelles.

CARBOHYDRATES

3 Hours

Carbohydrates – Structure and biological function of trehalose and cellobiose; structure (partial and hydrolytic products) and biological importance of homopolysaccharides – starch and glycogen (comparison of the two) cellulose and chitin structure; (partial and hydrolytic products) and biological importance of heteropolysaccharides – Hyaluronic acid and heparin

LIPIDS

4 Hours

Lipids – Definition, general functions, classification into simple, compound and derived lipids. Concept of essential and non-essential fatty acids. Structures of palmitic, stearic, oleic, linoleic, linolenic and arachidonic acids. Acylglycerols – Structure and biological importance. Properties – Saponification number and Iodine number – reaction, definition and significance. Rancidity-types of prevention. Phosphoglycerides – Structure and biological importance of - (i) Phosphatidylcholine (ii) Phosphatidylethanolamine (iii) Phosphatidylserine. (iv) Phosphatidylinositol. Concept of micelle and bilayer formation. Cell membranes – Composition and structure (Fluid Mosaic Model). Liposomes – definition and applications.

AMINO ACIDS AND PROTEINS

7 Hours

Amino acids – General structure, classification of α -amino acids based on nature of R groups (at pH 6.5) – structures of all the amino acids. Reactions of amino acids with (a) ninhydrin

(b) Sanger's reagent (c) Edman's reagent (d) CO_2 – importance of these reactions. Ionization of amino acids - zwitterionic structure and isoelectric point taking glycine as example (no titration curve required). Peptide bond – definition and characteristics. Classification of proteins based on (a) Structure (fibrous, globular and transmembrane) (b) Composition – simple and conjugated with examples, functions of proteins. Structural organisation of proteins – definition of primary structure, definition of secondary structure – brief description of α -helix and β -pleated sheet – comparison. Tertiary structure – definition, forces stabilizing tertiary structure. Quaternary structure – brief explanation taking Haemoglobin as example.

ENZYMES

6 Hours

Introduction to enzymes – concept of holoenzymes and requirement of cofactors (metal ions and coenzymes - only names with examples of its association). Classification and nomenclature (common and systematic names, EC number not required) into 6 main classes with an example of a reaction catalysed by each class of enzymes. Salient features of active site. Mechanism of enzyme action – Lock and key model using carboxypeptidase A as example (only brief qualitative explanation) and Induced fit model using Lysozyme as example (only brief qualitative explanation). Specificity of enzymes (with reactions) – broad specificity, absolute specificity (group, bond, stereospecificity - cis/trans and D/L) Enzyme Kinetics – effect of substrate concentration (Michelis-Menten equation to be given - no derivation); Lineweaver-Burke curve; Significance of K_m and V_{max} . Effect of pH and Temperature on kinetics (explanation of dumb bell shaped curve); Enzyme inhibition – Reversible and irreversible inhibitions. Brief mention of mechanism by which reversible (competitive, non-competitive and uncompetitive inhibitions only) occur with suitable examples. Lineweaver-Burke curves for these inhibitions (no quantitative treatment). Brief qualitative explanation of enzyme regulation, allosteric enzymes, allosteric regulation – only concept of feedback inhibition.

BIOENERGETICS AND BIOLOGICAL OXIDATION

4 Hours

Principles of Bioenergetics – bioenergetics and thermodynamics – concept of free energy – endergonic and exergonic reactions, concept of coupling reactions with at least one example of a coupling reaction. Structure of ATP, explanation of why it's a high energy molecule based on its structure. Hydrolysis of ATP and energetics of the reaction, mention of other high energy compounds. Brief overview of oxidation-reduction reactions – standard electrode potentials. Relationship between ΔG° and ΔE° . Definition of Electron transport chain; Components of ETC (no structures) and how they are successively oxidised and reduced. Diagrammatic representation of ETC (both from NADH and from reduced substrate via FADH_2); Electrode

potential values and points at which ATP is produced are to be given. Oxidative and Substrate level phosphorylation. Significance of P/O ratio.

METABOLISM

7 Hours

Metabolism – catabolism and anabolism – definition and comparison, Glycolysis – reactions and enzymes involved. Regulation of glycolytic pathway and energy balance sheet. Reactions of TCA cycle and energy balance sheet. Reactions of β -oxidation of fatty acids. Energy balance sheet of fatty acid oxidation. Metabolism of amino acids – transamination, deamination and decarboxylation with at least one example for each. Urea cycle – reactions, enzymes involved and significance of the cycle.

NUCLEIC ACIDS

4 Hours

Nucleic acids – nomenclature and structures of sugars, bases, nucleosides and nucleotides. Polynucleotides - Watson and Crick model of DNA (salient features) DNA Polymorphism - only mention of A, B and Z-DNA Biological importance of DNA. Types of RNA and their biological role.

NUCLEIC ACID METABOLISM

3 Hours

Central dogma of Molecular Biology, DNA replication- brief historical background – proof of semi-conservative mode of replication. Brief account of enzymatic aspects of prokaryotic DNA replication. Transcription – brief mechanism (details of factors not required). Genetic code (general features only). Translation – amino acid activation, initiation, elongation and termination of protein synthesis (details of factors not required)

VITAMINS AND HORMONES

5 Hours

Vitamins – definition, classification of vitamins. Common sources and deficiency manifestations of water soluble (Vit B complex and Vit C) and fat soluble (Vit A, D, E, and K). Coenzyme functions of B-complex vitamins (Niacin, Flavin, Thiamine, Pyridoxal Phosphate, pantothenic acid, lipoic acid, cobalamine – no structures only descriptive treatment of the enzymatic reactions they are involved in).

Hormones – Definition and classification. (i) Amino acid derivatives – Epinephrine and Thyroxine – brief outline of biological roles (no structures). Peptide and Polypeptide Hormones – Insulin, glucagon, oxytocin, vasopressin – brief outline of biological roles (no structures). Steroid Hormones – β -estradiol, progesterone and testosterone – brief outline of biological roles (no structures)

REFERENCES:

1. Biochemistry, Debajyoti Das Academic Publishers
2. Fundamentals of Biochemistry, J.L Jain, S Jain and N. Jain S Chand Publications
3. Principles of Biochemistry, A. L. Lehninger, CBS, New Delhi (1993).
4. Biochemistry, L. Stryer, 2nd edition CBS, New Delhi (1986).
5. Biochemistry, J. David Rawn, Neil Patterson.
6. Biochemistry, Voet and Voet, 2nd edition, John Wiley (1995).
7. Outlines of Biochemistry, E. E. Conn and P. K. Stumpf, Wiley Eastern (1976).
8. Biochemistry: The Chemical Reactions of Living Cells, D. E. Metzler, Academic Press (1997).

CH 6P₁ PRACTICAL-VII Inorganic Quantitative Analysis And Qualitative Spectral Analysis 11 sessions (3 hrs/week)

1. Estimation of zinc using EDTA.
2. Estimation of the hardness of water using EDTA solution.
3. Estimation of calcium in limestone.
4. Estimation of iron in haematite.
5. Estimation of copper in brass.
6. Gravimetric estimation of nickel as Ni(DMG)₂.
7. Gravimetric estimation of aluminium as aluminium oxinate.
8. Gravimetric estimation of sulphate as barium sulphate.
9. Electrogravimetric estimation of copper.
10. Recording and interpretation of IR spectra of some compounds.
11. Recording and interpretation of UV-visible spectra of some compounds.
12. Any other suitable experiment.

REFERENCES:

1. Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, ELBS, (1989).
2. Practical Organic Chemistry, Mann and Saunders (1980).
3. Textbook of Practical Organic Chemistry, A I Vogel (1996).

CH 6P₂ PRACTICAL – VIII Practical Biochemistry 11 sessions (3 hrs/week)

1. Qualitative tests for carbohydrates and lipids.
2. Qualitative tests for amino acids and proteins.
3. Paper chromatography for separation of biomolecules.
4. Colorimetric estimation of glucose by DNS.
5. Estimation of reducing sugar by Doubowski method.
6. Estimation of protein by Biuret method.
7. Estimation of blood urea by diacetyl monooxime method.
8. Estimation of Ca²⁺ in milk by oxalate method.
9. Estimation of Creatinine in urine by Jaffe's method.
10. Assay of alkaline phosphatase /urease from horse gram (sprouted).
11. Preparation of buffers, determination of pH.
12. Effect of time, temperature and pH on enzyme activity.
13. Detection of an adulterant in food.
14. Extraction of oil from oil seeds.
15. Some steps in protein purification.
16. Molecular weight determination of a polymer by viscosity method.
17. Any other suitable experiment.

REFERENCES:

1. Practical Clinical Biochemistry, H. Varley ,4th edition, CBS Indian edition (1988).
2. An Introduction to Practical Biochemistry, David Plummer, Tata McGraw Hill (1979).
3. Laboratory Manual in Biochemistry, J. Jayaraman, Wiley Eastern (1981).