U.G. 3rd SEMESTER SYLLABUS

DEPARTMENT OF CHEMISTRY

COTTON UNIVERSITY

PAPER : CHM 301C

INORGANIC CHEMISTRY- II

(Credits: 3+0+2=5)

Theory: 45 hours

Unit 1: Chemistry of s-Block Elements (10 Lectures)

General consideration: melting point, flame colours, reducing nature, diagonal relationships and anomalous behaviour of first member of each group.

Chemical properties: Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water.

Alkali and alkaline earth metal compounds (ease of formation, thermal stability and solubility): hydrides, oxides, peroxides, super oxides, carbonates, nitrates, sulphates. Solutions of alkali and alkaline earth metals in liquid ammonia and their properties.

Spin isomers of hydrogen, hydrates, clatharates and inclusion compounds.

Unit 2: Chemistry of p-Block Elements (12 Lectures)

Diagonal relationship between boron and silicon and anomalous behaviour of first member of each group. Preparation, properties, bonding and structure of the following: Allotropes of carbon (including fullerenes and graphene), intercalation compounds, carbides, cyanogens, oxides and oxy-acids of carbon. Allotropes of phosphorous. Hydrides, oxides and oxy-acids of nitrogen and phosphorous. Hydrazine, hydroxylamine and hydrogen azide, clinical use of NO and N_2O, Superoxide and oxygen fluorides. Allotropes of sulphur, oxides, hydrides, oxyacids and per-acids of sulphur.

Interhalogen compounds, polyhalides, pseudohalogen, oxides and oxyacids of halogens. Noble gas compounds – Xenon oxides and fluorides.

Inorganic chains, ring and cages: Silicate, alumino silicates, zeolites, silicones, borazine, phosphazine, S_4N_4, P_4, P_4O_6, P_4O_{10}, diborane, boron cage compounds, carboranes and metallocarboranes.

Unit 3: Nuclear Chemistry (9 Lectures)

Structure of the nucleus, Nuclear Models (Liquid Drop, Shell), Nuclear Forces, Nuclear Stability, mass defect and binding energy. Types of Nuclear reactions, Q value, nuclear cross sections, Fission, Fusion, Nuclear Reactors.

Radioactivity, Theory of radioactive disintegration, Radioactive decay and equilibrium, Rates of disintegration, the radiochemical series. Transmutation of elements and artificial radioactivity. Isotopes of elements, methods of separation of isotopes, application of isotopes (tracer technique, neutron activation analysis, radiocarbon dating).

Unit 4: Symmetry and Point Group of Molecules (8 Lectures)

Symmetry elements and symmetry operation, concept of point group, point groups of simple molecules, symmetry of octahedron, tetrahedron and square planar complexes, structure and symmetry of inorganic compounds (coordination number 2-6), shape and symmetry of s, p, and d orbital.

Unit 5: Theoretical Principles in Qualitative and Quantitative Analysis (6 Lectures)

Basic principles involved in analysis of cations and anion, Solubility product, Common ion effect, Principles involved in separation of cations into groups, group reagents, Interfering anions (F^-, BO_3^-, PO_4^{3-} and AsO_4^{3-}) and need to remove them after group II.

Acid-base, oxidation-reduction and complexometric titrations using EDTA; precipitation reactions; use of indicators; use of organic reagents in inorganic analysis.

PRACTICAL: 60 HOURS

Unit 6: Inorganic Chemistry Lab (2 Credits)

Qualitative Inorganic Analysis: Analysis of mixture of two inorganic salts containing total of four cations and anions including interfering anions.

(At least five such mixtures of inorganic salts must be analysed during the session)

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PAPER : CHM 302C

ORGANIC CHEMISTRY- II

(Credits: 3+1+1=5)

Theory: 60 Lectures

Unit 1: Chemistry of Halogenated Hydrocarbons (16 Lectures)

Alkyl halides: Methods of preparation and physical properties. Chemical properties: nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation (including preparation from diazonium salts) and properties, nucleophilic aromatic substitution; S_NAr, Benzyne mechanism.

Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Organometallic compounds of Li and Mg (Grignard reagent) and copper– Use in synthesis of organic compounds.

Unit 2: Alcohols, Phenols, Ethers and Epoxides (16 Lectures)

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols; Mechanism of dehydration of alcohol with H_2SO_4, dehydration in basic condition, conversion of alcoholic group to a good leaving group.

Oxidations (Swern oxidation, Oppenaeur oxidation, chromium trioxide, selenium dioxide, PCC, PDC, DCC), Oxidation of diols by periodic acid and lead tetraacetate, Pinacol- Pinacolone rearrangement;

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries, Claisen, dienone-phenol rearrangements with mechanism;

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$

Unit 3: Carbonyl Compounds (16 Lectures)

Structure, reactivity, preparation and properties.

Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro, Wittig reaction, McMurry Reaction, Darzens reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α – substitution reactions, reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, Birch), Bouvaelt- Blanc Reduction;

Addition reactions of α, β- unsaturated carbonyl compounds: Michael addition, Robinson Annulation

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Unit 4: Carboxylic Acids and their Derivatives (12 Lectures)

General methods of preparation, physical properties and reactions of monocarboxylic acids, effect of substituents on acidic strength. Typical reactions of dicarboxylic acids , hydroxy acids and unsaturated acids.

Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic sustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Wolff rearrangement, Hofmann- bromoamide degradation and Curtius, Lossen rearrangement, Favorskii rearramgement.

PRACTICAL: 30 HOURS

Unit 5: Organic Chemistry Lab (1 Credit)

1. Chromatography
   a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
   b. Separation of a mixture of two sugars by ascending paper chromatography
   c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol or nitroanilines by thin layer chromatography (TLC)

2. Extraction of caffeine from tea leaves.

3. Extraction and identification of DNA from green peas and onions

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PAPER : CHM 303C

PHYSICAL CHEMISTRY- III

(Credits:4+1+0=5)

Theory: 75 Lectures

Unit 1: Phase Equilibria (20 Lectures)

Concept and definitions of phases, components and degrees of freedom, derivation of Gibbs phase rule. Concept of the number of components for various reactive systems. Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria. Phase diagram of one component systems (water, sulphur) with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic point, congruent and incongruent melting points.

Binary solutions: distillation of binary miscible liquids (ideal and non ideal), azeotropes, lever rule. Partial miscibility of liquids, conjugate solutions, CST. Distillation of immiscible liquid mixtures – steam distillation. Nernst distribution law for a solute in an immiscible liquid pair: its applications.

Chemical potentials - chemical potential of a component in an ideal mixture – fugacity, activity, activity coefficients. Dependence of chemical potential on temperature and pressure.

Unit 2: Electrochemical Conduction (20 Lectures)

Quantitative aspects of Faraday's laws of electrolysis. Ion transport and conductivity, mobility of ions and conductivity. Concept of current density and of electric field strength – their interrelation. Transport number of ions and methods for their determination. Conductance, conductivity, molar conductivity and equivalent conductivity, Kohlrausch's law of independent migration of ions. Application of conductance measurement in (i) degree of dissociation of weak electrolytes and (ii) conductometric acid-base titrations.

Dependence of molar conductivity on concentration and temperature - the Debye-Huckel-Onsagar equation. Activity of ions, mean ionic activity, ionic strength of solutions, Debye-Huckel theory (elementary ideas only) of strong electrolytes. Dependence on alternating current frequency – the Debye-Falkenhagen effect.

Unit 3: Ionic Equilibrium (15 Lectures)

Strong and weak electrolytes, dissociation equilibria of weak electrolytes, Ostwald's dilution law. Concept of pK_a and pK_b of acids and bases. Henderson-Hasselbalch equation. Buffer solutions and buffer action.

Strong and weak electrolytes, degree of ionisation, factors affecting degree of ionisation, ionisation constant and ionic product of water. Ionisation of weak acids and bases, pH scale, common ion effect, Henderson-Hasselbalch equation and its derivation. Dissociation constants of dibasic and tribasic acids – stepwise neutralisation with a base. Hydrolysis of salts – calculation of hydrolysis constant, degree of hydrolysis and relations for pH. Buffer solutions and buffer capacity. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Theory of acid–base indicators; selection of a suitable indicator.

Unit 4: Chemical Kinetics (20 Lectures)

Concept of reaction rate and rate laws, rate laws in terms of the advancement of a reaction. Order and molecularity of reactions. Differential rate equations and integrated rate expressions for zero, first and second order reactions. Half-life periods and their dependence on initial concentrations. Temperature dependence of reaction rates, Arrhenius plots.

Consecutive, concurrent and opposing reactions. The steady state approximation and the rate determining step approximation; kinetics of decomposition of N_2O_5. Experimental determination of rate and order of reactions: various methods and techniques.

Kinetics of chain reactions, H_2-Br_2 reaction, thermal decomposition of acetaldehyde, branching and non-branching chain reaction, H_2-O_2 reaction, concept of explosion limits. Introduction to polymerisation kinetics of free-radical chain polymerisation.

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