UNIVERSITY OF MUMBAI

No.UG / 129 of 2009

CIRCULAR :-

A reference is invited to the Ordinances, Regulations and syllabi relating to the Bachelor of Science (B.Sc.) degree course ***vide*** Pamphlet No. 141 and to this office Circular No.UG/346 of 2003 dated 21st July, 2003 and the Principals of the affiliated colleges in Science are hereby informed that the recommendation made by the Board of Studies in Chemistry at its meeting held on 23rd December, 2008 has been accepted by the Academic Council at its meeting held on 13th February, 2009 ***vide*** item No.4.1 and that, in accordance therewith, the syllabus and scheme of examination in the subject of Chemistry at the S. Y. B. Sc. is revised as per **Appendix** and that the same has been brought into force with effect from the academic year 2009-2010.

MUMBAI-400 032
4th May, 2009

PRIN K VENKATARAMANI
REGISTRAR

To,

The Principals of the affiliated colleges in Science.

A.C./4.1/13.02.2009

No.UG/ 29-A of 2009, MUMBAI-400 032 4th May, 2009

Copy forwarded with compliments for information to: -

1) The Dean, Faculty of Science
2) The Chairman, Board of Studies in Chemistry.
3) The Controller of Examinations,
4) The Co-Ordinator, University Computerization Centre.

(D.H. KATE)
DEPUTY REGISTRAR
U.G./P.G SECTION

Copy to: -

The Director, Board of College and University Development, , the Deputy Registrar (Eligibility and Migration Section), the Director of Students Welfare, the Executive Secretary to the Vice-Chancellor, the Pro-Vice-Chancellor, the Registrar and the Assistant Registrar, Administrative sub-center, Ratnagiri for information .

The Controller of Examinations (10 copies), the Finance and Accounts Officer (2 copies), Record Section (5 copies), Publications Section (5 copies), the Deputy Registrar, Enrolment, Eligibility and Migration Section (3 copies), the Deputy Registrar, Statistical Unit (2 copies), the Deputy Registrar (Accounts Section), Vidyanagari (2 copies), the Deputy Registrar, Affiliation Section (2 copies), the Director, Institute of Distance Education, (10 copies) the Director University Computer Center (IDE Building), Vidyanagari, (2 copies) the Deputy Registrar (Special Cell), the Deputy Registrar, (PRO). the Assistant Registrar, Academic Authorities Unit (2 copies)and the Assistant Registrar, Executive Authorities Unit (2 copies) . They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above Circular and that, no separate Action Taken Report will be sent in this connection. the Assistant Registrar Constituent Colleges Unit (2 copies), BUCT(1 copy), the Deputy Account Unit V(1 copy), the In-charge Director, Centralize Computing F...), the Recr...

Enclosure to Item No. 4.1
13.2.2009

UNIVERSITY OF MUMBAI

Revised Syllabus & Scheme

for the

S.Y.B.Sc. Examination

In

Chemistry

(With effect from the academic year 2009-2010)

University of Mumbai
Revised syllabus S.Y.B.Sc. in Chemistry
(w.e.f. the academic year 2009-10)

Paper I

Total Lectures 90

Physical and Industrial Analytical chemistry
[Numerical problems are expected on all units except Unit 6]

Term- I

Unit I
Chemical Thermodynamics: [15L]
1] Gibbs free energy and Helmholtz's free energy, variation of Gibbs's free energy with temperature and pressure, Gibb's –Helmholtz equation.
2] Physical equilibria involving pure substances, Clapeyron's equation, and variation of vapour pressure with temperature, Clausius- Clayperon equation and its application. Partial molal properties, partial molal volume and chemical potential, Gibbs –Duhem equation.
3] Variation of chemical potential with pressure and temperature, fugacity, activity and their relationship with chemical potential, activity and activity coefficient.
4]Thermodynamic derivation of Law of mass action ,K_p,K_C and their inter-relation, van't Hoff's reaction isotherm and reaction isochore.

Unit II
Solutions of electrolytes: [15L]
1] Electronic and electrolytic conductors, conductance, specific conductance, equivalent conductance, molar conductance, determination of molar conductance, variation of molar conductance with concentration for strong and weak electrolytes, concept of limiting molar conductance,
2] Debye- Huckel theory of conductance of strong electrolytes,ionic atmosphere. relaxation effect, electrophoretic effect.
3]Kohlrausch's law of independent migration of ions.
Applications of Kohlrausch's law
[a] Determination of limiting molar conductance of a weak electrolyte,
[b] Determination of dissociation constant of a weak acid
[c] Determination of solubility product of a sparingly soluble salt.
4]Migration of ions, transport number, dependence of transport number on the velocity of the ion, Hittorf's rule for unattackable electrodes illustrate with ions having equal and unequal speeds, moving boundary method for the determination of the transport number, factors affecting the transport number of an ion.
5] Relationship between transport number ionic mobility, and equivalent conductance.

Unit III

Introduction to analytical chemistry and visible spectroscopy: [15L]

A] Introduction to analytical chemistry:

1] Analytical chemistry qualitative and quantitative analysis, analytical chemistry and chemical analysis, classification of analytical methods with emphasis on detection limit and sensitivity.

2] Steps involved in chemical analysis: sampling, obtaining a sample, processing the sample, selection of a method for analysis, calibration and actual analysis, data collection, data processing, presentation of results and interpretation.

3] Performance characteristics of an analytical method: accuracy, precision, detection limit, dynamic range, sensitivity, selectivity.

4] Quantitative analysis with calibration curve and standard addition method.

5] Applications of analytical methods in various fields such as organic, pharmaceuticals, electronic and environmental analysis.

B] Visible spectroscopy:

1] U.V.and Visible spectroscopy,absorption spectroscopy, terms involved: radiant power, absorbance, transmittance, percentage transmittance, wavelength of maximum absorption.

2] Statement of the Beer's law and the Lambert's law, [derivation expected] combined expression, molar extinction coefficient, deviations from the Beer –Lambert's law, limitations.

3] Components of an optical instrument, photometers and spectrophotometers, construction of a single beam photometer.

Term-II

Unit IV

Phases in equilibria: [15L]

1] Introduction to the terms: phase, component, degrees of freedom, Gibbs phase rule.

2] **Two component systems:**

A] liquid-liquid mixtures, completely miscible liquids, phase diagrams, pressure composition and temperature composition diagrams, Raoult's law, ideal solutions, distillation of mixtures forming ideal solutions, fractional distillation, distillation under reduced pressure, deviations from the Raoult's law, positive and negative deviations, nonideal solutions, azeotropes distillation of azeotropic mixtures, breaking of azeotropes.

B] liquid -liquid mixtures, partially miscible liquids, partially miscible liquid pairs exhibiting lower critical solution temperature, upper critical solution temperature and both lower and upper critical solution temperature.

C] liquid- liquid mixtures, completely immiscible liquids, steam distillation.

Unit V

Electrochemical cells and ionic equilibria:

Electrochemical cells: [15L]

1] Galvanic and electrolytic cells, , types of electrodes, ion specific and ion selective, comparison, types of ion specific electrodes, i] metal- metal ion electrodes, ii] gas electrodes, iii] metal –metal insoluble salt electrodes, iv] redox electrodes,

2] Cell presentation and cell reaction.[students are expected to write the cell reaction for a given cell and vice versa.]

3] Reversible and irreversible cells, chemical and concentration cells, primary and secondary cells.

4] Thermodynamic parameters [ΔG, ΔH and ΔS] for the cell reaction taking place in a cell.

5]Nernst's equation for cell emf and hence for a single electrode potential [Derivation expected.] 6] Determination of equilibrium constant from emf measurements.

Ionic equilibria:

1] Concept of pH, pOH, calculations of pH of solutions of acids and bases,

2] Buffer, buffer capacity, Henderson's equation for acidic and basic buffers [derivation expected]

Unit VI

Introduction to titrimetric analysis and use of instrumental methods in titrimetric analysis

Introduction to titrimetric methods of analysis [15L]

1] Requirements for a reaction to be used in titrimetric analysis, classification of titrimetric analysis, terms: titration, titrand, titrant, titre value, indicator, endpoint, equivalence point, titration error,

2] Calibration of the volumetric glassware, burettes, pipettes and volumetric flasks.

3] Theory of acid base indicators, choice of an indicator for the titration dependence on the pH at the equivalence point.

Use of instrumental methods in titrimetric analysis:

1] Conductometric titrations: basic principles, experimental set up, titration curves in the titration of i] strong acid vs. strong base, ii] weak acid vs. strong base, iii] weak acid vs. weak base. iv] Mixture of strong and weak acid/strong and weak base vs. strong base/ weak base or strong acid/weak acid. v] sodium chloride vs. silver nitrate vi] barium hydroxide vs. magnesium sulphate advantages and limitations.

2] Potentiometric titrations: basic principles, concept of indicator electrode, indicator electrodes for different types of titrations, determination of end point from the graphs of E vs. V, $\Delta E/\Delta V$ vs. mean volume, $\Delta^2E/\Delta V^2$ vs. mean volume ,advantages and limitations.

3] Photometric Titrations: basic principles, titration curves, advantages and limitations.

4] Use of computers, use of spread sheets.

Chemistry Paper-II

Inorganic and Industrial Chemistry

(Total Lectures 90)

Term-I

Unit –I

Chemical Bonding and Molecular Structure 15L

1. Valence Bond Theory (VBT): 5L
   i. Hybridization involving the use of 'd' orbitals as in $BaCl_2$ (sd), MnO_4^- (sd^3), and PCl_5 (sp^3d)
   ii. Concept of Resonance and Resonance energy, Formal Charge, with examples
   iii. Limitations of VBT.
2. Molecular Orbital Theory (MOT) : 10L
   i. Conditions for the formation of molecular orbitals
   ii. Linear combination of atomic orbitals to obtain molecular orbitals (LCAO-MO approach)
   iii. Application of LCAO-MO approach to the formation of :
      a) Homo-nuclear diatomic molecules : H_2, He_2, Li_2, Be_2, C_2, N_2, O_2, F_2 and Ne_2. (Discussion should include $2s$-$2p$ interaction; stabilization of π ($2p_x$, $2p_y$ orbitals) MOs in B_2, C_2 and N_2 with experimental evidences; bond order and correlation with stability, bond length, bond energy and magnetic properties of all the homo-nuclear diatomic molecules mentioned)
      b) Bond order in O_2, O_2^+, O_2^-, O_2^{2-} and examples of the occurrence of the molecular ions in $[O_2]^+[PtF_6]^-$, KO_2 and Na_2O_2.
      c) Hetero-nuclear diatomic molecules or molecular ions : CO, NO, CN^-, and HCl. (Discussion should include comparison with the approach for homo-nuclear diatomic molecules, molecular orbital diagrams with explanations of bond order, stability, magnetic behavior and polarity).

Unit – II

Chemistry of Transition Elements : Bonding in Coordination Compounds and Gravimetric Analysis

15L

1. Transition Elements : 3L
   i. Definition and general characteristics of transition elements
   ii. Chemistry of 3d-transition elements with reference to :
      a) Electronic Configuration
      b) Oxidation States
      c) Colour and Magnetic property
      d) Formation of Coordination compounds
      e) Applications in general.

2. Bonding in Coordination Compounds: Valence bond Theory: 4L
   i. Application to 4,5,6-Coordinate compounds
   ii. Electro-neutrality principle and back-bonding.

3. Gravimetric Analysis: 8L
   i. Definition and Types of gravimetric analysis
   ii. Precipitation Gravimetry with respect to Theory and Practice :
      a. Solubility considerations: Common ion effect; diverse ion effect , pH, temperature and nature of solubility
      b. Controlling particle size.
   iii. Treatment of precipitates in gravimetry:
      a. Digestion
      b. Filtration and Washing
      c. Drying and Ignition
   iv Use of Organic Reagents in gravimetric analysis

(Numerical problems on this topic expected.)

Unit – III

Industrial Inorganic Chemistry

15L

1. Physico-Chemical Principles : 6L
   i. Criteria for spontaneity of Chemical Reactions
   ii. Electrolysis

iii. Effect of catalysts

iv. General principles of metallurgy.

2. Manufacture of Bulk Chemicals : 4L

i. Sulfuric acid (by contact process)

ii. Ammonia (by Haber's process)

3. Extraction and Purification of : 5L

i. Copper (from pyrites) by pyrometallurgy and electrolysis

ii. Silver by hydrometallurgy

iii. Aluminum by electrometallurgy.

Term-II

Unit IV

Acids and Bases, Chemistry of Elements and Organometallic Componds

15L

1.Acids and Bases : 5L

i. Appreciation of various concepts due to:

a. Arrhenius

b. Lowry-Bronstead

c. Lux-Flood

d. Lewis

e. Solvent-System

f. Usanovich.

ii. Pearson's classification of acids and bases and his principle of HSAB.

2.Chemistry of Group 15 and Group 16 elements : 5L

General discussion of trends in their physical and chemical properties, Physical properties of hydrides of Group 15 and Group 16 elements with respect to hydrogen bonding .

3. Organometallic Compounds: 5L

i. Introduction, definition, classification on the basis of :

a. Hapticity, and

b. Nature of metal-carbon (M-C) bond.

ii. Eighteen Electron Rule with respect to applications and exceptions;

iii. Metal carbonyls with respect to :

a. Classification and bonding

b. General methods of preparation, and

c. Properties.

iv. Applications of organometallic compounds.

Unit – V

Chemistry of Group-17 and Group-18 Elements and Bio-Inorganic Chemistry

1. Chemistry of Group 17 and Group 18 elements: 15L 6L

i. General trends in physical and chemical properties

ii. Chemistry of pseudo-halogens with respect to :

a) Comparison with halogens

b) Preparation and uses.

2.Chemistry of Group-18 elements with respect to : 4L

i. History, and

ii. Preparation and structures of xenon fluorides and oxy fluorides.

3. Bio-Inorganic Chemistry : 5L

i. Metaloporphyrins

ii. Chlorophyll

iii. Cytochromes

iv. Hemoglobin and myoglobin : oxygen transport and storage.

Unit - VI

Industrial Inorganic Chemistry 15L

1. Corrosion and Methods of Protection of Metals: 7L

i. Introduction (to include economics and importance of corrosion)

ii. Types of corrosion

iii. Electrochemical theory of corrosion

iv. Methods of Protection :

a. Coating

b. Electroplating

c. Cathodic protection

d. Anodizing

e. Sacrificial Coating.

2. Environmental Studies:

i. Multidisciplinary nature of environmental studies: Definition, scope and importance 8L

ii. Environmental Pollution: Definition, Causes, Effects and Control measures of: 2L

a. Water pollution

b. Soil pollution. 3L

iii. Role of an individual in prevention of pollution and Pollution case studies with reference to water and soil pollution. 1L

iv. Environment Protection Act : 2L

a) Air (Prevention and Control of Pollution) Act

b) Water (Prevention and Control of Pollution) Act

c) Public awareness.

Paper III

Organic and Industrial Chemistry

TERM I

Total Lectures 90

UNIT I

15 L

1: Nomenclature **2L**

Nomenclature of polysubstituted aromatic compounds containing different functional groups: Polysubstituted benzenes, tri substituted naphthalenes, disubstituted anthracenes. Nomenclature of ethers, epoxides, and sulphur compounds.

2: Mechanism of organic reactions **7L**

2.1. The mechanism of reactions involving the following reactive intermediates:

2.1.1. **Carbocations:** Different types of carbocations, such as alkyl, allyl, benzyl. S_N1 reaction. Electrophilic addition across an olefinic double bond. Elimination - E1 mechanism. Rearrangement Wagner Meerwein rearrangement

2.1.2. **Carbanions:** Concept of carbon acid. Alkylation of carbon acids (active methylene compounds and terminal alkynes) using alkyl halides, and synthetic applications of these reactions. Reactions of Grignard reagents at carbonyl group. Aldol addition.

2.1.3. **Carbon radicals:** General reactions of radicals – abstraction, addition to C=C, combination, disproportionation. Addition of HBr to alkenes in presence of peroxide. Polymerization. Redox reaction - Kolbe electrolytic method.

2.1.4. **Carbenes:** Generation of carbenes: through alpha elimination, from diazoalkanes, from ketenes. Structure and stability. Reactions: insertion into C-H bond and addition to olefin.

2.2. **Tautomerism:** Keto-enol tautomerism in aldehydes and ketones, acid and base catalysed enolisation, enol content and stabilized enols β-ketoesters, β-diketones, phenols.

3: Aromatic Electrophilic Substitution Reaction **6L**

3.1. Huckel rule of aromaticity and its applications to carbocyclic benzenoid and nonbenzenoid compounds and ions. Concept of antiaromaticity and homoaromaticity.

3.2. General mechanism of aromatic electrophilic substitution reaction with energy profile diagram.

3.3. Drawing resonance structures of monosubstituted benzenes – Activated and deactivated aromatic rings

3.4. Effect of electron withdrawing and electron donating substituents on the orientation of an incoming electrophile on the basis of – (i) electron density distribution (ii) stability of intermediate

Cases to be studied: Monosubstituted benzenes containing groups – Alkyl, amino, hydroxyl, alkoxy, halo, formyl, acyl, nitrile, nitro, carboxy.

UNIT II **15 L**

4. **Aromatic Hydrocarbons** 3L

4.1. Structures of benzene, naphthalene, linear and angular acenes.

4.2. **Alkyl arenes:** Preparation of alkyl arenes through reforming, Friedel-Crafts alkylation, with mechanism, using – Olefins, alcohols, alkyl halides.

4.3. Reactions of alkyl arenes – side chain oxidation, ring vs side chain halogenation (mechanism).

5 Haloarenes 4L

5.1. **Preparation of haloarenes:** Halogenation of arenes - Halogenation of benzene and substituted benzenes with molecular halogens (mechanism), limitations.

5.2. **Reactions of haloarenes:** Lack of reactivity of aryl halides under S_N1 and S_N2 reactions. General mechanism (addition-elimination) of aromatic nucleophilic substitution reaction, with energy profile diagram. Effect of substitutents on the reaction - hydrolysis and amination of haloarenes. Benzyne intermediate mechanism (elimination-addition) of aromatic nucleophilic substitution reaction (cine substitution). Grignard reagent formation. Ullmann reaction.

5.3. Applications of aromatic halogen compounds

6: Phenols 3L

6.1. **Preparation of phenols:** Preparation from (i) halobenzenes, (ii) from aromatic sulphonic acids (benzene and naphthalene sulphonic acids) (iii) isopropyl and 2-butylbenzene by hydroperoxide method.

6.2. Reactions of phenols: Acidity of phenols - effect of substituents on acidity of phenols. Salt formation, Etherification – direct reaction with alcohol, Williamson Synthesis. O-acylation, Halogenation, Nitration, Fries rearrangement of aryl carboxylates, Claisen rearrangement of allyloxyarenes.

6.3. Applications of phenols

7. **Ethers and Epoxides** 5L

7.1. Ethers:

7.1.1. **Preparation:** Dehydration of alcohols (mechanism), Williamson synthesis (mechanism).

7.1.2. **Reactions:** Acid catalyzed cleavage reaction with HX (mechanism)

7.1.3. **Applications:** Applications of ethers, Crown ethers: Structure; 12-crown-4 and 18-crown-6 and their uses.

7.2. Epoxides:

7.2.1. **Preparation:** Oxidation of olefins – ethylene oxide; Reaction of per acids with olefins; from vicinal halohydrins

7.2.2. **Reactions:** Reactivity. Ring opening reactions by nucleophiles (a) In acidic conditions: hydrolysis, reaction with – HX, alcohol, HCN. (b) In neutral or basic conditions: ammonia, amines, metal cyanides, Grignard reagents, alkoxides

7.2.3 Applications of epoxides.

UNIT III 15 L

8 **Sources of Organic Compounds** 8L

8.1 **Sources:** (a) Non-renewable: coal, petroleum (crude oil) and natural gas. (b) Renewable: biomass

8.2 **Coal:** Structure and types of coal, origin of coal. Destructive distillation of coal, coal tar refining, coal liquefaction (coal to liquid), coal gasification- synthesis gas (syn gas), hydropyrolysis

8.3. **Petroleum:** Characteristics, composition and origin of petroleum. Refining of petroleum. Catalytic cracking and reforming, hydrocracking, thermal cracking, steam cracking

8.4 **Natural gas:** Composition. Conversion of methane to - higher alkanes, synthetic diesel (gas to liquid), methanol, aromatic compounds. Natural gas hydrates: occurrence, structure.

8.5. **Synthesis gas (syn gas):** Production of syn gas from - coal, natural gas, biomass. Composition. Synthetic uses of syn gas - Separation of H_2, Production of – methanol, alkanes, hydroformylation of olefins, synthesis of aromatic hydrocarbons. Fischer-Tropsch synthesis – Synthetic diesel (biomass to liquid),

8.6. Oligomerisation and metathesis of olefins.

8.7 **Biomass:** Transforming biomass into chemicals (pyrolysis) and synthesis gas

8.8 **Biofuels:** Ethanol, biodiesel, synthetic diesel, methanol

9 **Chemical Industry** 4L

Idea of a chemical plant, different units, block diagrams and flow diagrams. Flow diagrams: principle, importance, typical elements. Typical flow diagram of a single unit processe. Idea of flow diagrams of multiple process units. Continuous vs batch operations. Raw materials, intermediates, end products, by-products, waste. Unit processes – nitration as an example.

10 **Environmental aspects of Chemical Industry** 3L

Volatile Organic Compounds (VOC), Greenhouse effect: Ozone depletion, important greenhouse gases and their sources. Hydrocarbons as air pollutants, Harmful effects of industrial effluents. Carbon emission - Carbon credit, carbon neutrality, carbon offsetting. Material Safety Data Sheet (MSDS).

TERM II

UNIT IV 15L

11. **Aromatic Nitrogen compounds** 8L

11.1 **Aromatic nitro compounds**

11.1.1. **Preparation:** Nitration using mixed acid, Preparation of mononitro- and dinitro-compounds through nitration of benzene (mechanism), nitrobenzene, toluene, chlorobenzene, naphthalene, anisole.

11.1.2 **Reactions:** Reduction of nitro compounds under different conditions.

11.1.3 Applications of nitro compounds: In the preparation of amines and explosives.

11.2 **Aromatic amino compounds**

11.2.1 **Preparation:** Reduction of aromatic nitro compounds using - catalytic hydrogenation, dissolving metal reduction using - Fe-HCl, Sn-HCl, Zn-HOAc, NaHS, Amination of halobenzenes, Chemoselective reduction of dinitrobenzene, Hoffmann bromamide reaction.

11.2.2. **Reactions:** Basicity of aromatic amines - effect of substituents on basicity of aniline. salt formation, N-alkylation, N-acylation, halogenation, reductive alkylation, Diazotization of aromatic primary amines (mechanism), Reactions of aryl diazonium salts- Sandmeyer and Gattermann reactions, Replacement of diazo group by H-, -OH, -CN; Gomberg reaction, Azo-coupling reaction with phenols/naphthols and aromatic amines. Reduction of diazonium salt to aryl hydrazine. Formation of azo- and hydrazo-benzenes.

Chromophore - auxochrome concept, azo group as a chromophore, azo dyes.

12. **Aromatic Aldehydes and Ketones** 7L

12.1. **Preparation of aromatic aldehydes:** Preparation using CO (Gattermann-Koch reaction), HCN (Gattermann reaction), DMF/$POCl_3$ (Vilsmeier-Haack reaction), Reimer-Tiemann reaction (mechanism), Oxidation of methylarenes, Rosenmund reaction,

12.2. **Preparation of aromatic ketones:** Friedel-Crafts acylation using acid chloride and acid anhydride (mechanism)

12.3. **General reactions:** Reactions with - Ammonia and amines, hydroxylamine, phenyl hydrazine, hydrogen cyanide, sodium bisulphite.

12.4. **Reactions with mechanism:** Knoevenagel reaction, Claisen-Schmidt reaction, benzoin reaction, Cannizzaro reaction.

12.5. Applications of aromatic aldehydes and ketones

UNIT V 15L

13. **Aromatic acids** 6L

13.1. **Aromatic carboxylic acids:**

13.1.1. **Preparation of mono- and di-carboxylic acids:** Preparation by - side chain oxidation of alkyl benzenes, reaction of Grignard reagents with solid carbon dioxide, hydrolysis of aryl nitriles, Kolbe-Schmidt reaction (mechanism)

13.1.2. **Reactions of aromatic carboxylic acids:** Acidity, Effect of substituent on the acidity of benzoic acid, Acid catalyzed esterification, esterification by alkylation, Conversion to acid chloride, amide and anhydride. Reduction and decarboxylation.

13.1.3. Applications of aromatic carboxylic acids

13.2. **Aromatic sulfonic acids**

13.2.1. Preparation of aromatic sulfonic acids: Commonly used sulfonating agents. Sulfonation of benzene (with mechanism), mono-substituted benzenes and naphthalene.

13.2.2. Reactions: Acidity of arene sulfonic acids. Comparative acidity of carboxylic acids and sulfonic acids, salt formation, desulfonation. *Ipso* substitution. $-SO_3H$ as a solubilizing and blocking group, preparation of sulfonate esters.

13.2.3. Uses of- pTSA, sulfonated polystyrene, naphthalene monosulfonic acids.

13.2.4. Aromatic chlorosulfonyl compounds: Aromatic chlorosulfonation using chlorosulfonic acid. Reaction of aryl sulfonyl chlorides with water, ammonia and amines. Preparation of saccharin, Chloramine-T, sulfanilamide.

14 **Stereochemistry** 5L

14.1. **Assigning stereodescriptors to chiral centres:** Cahn-Ingold-Prelog (CIP) Rules of assigning absolute configuration (R and S) to a stereogenic centre. Assigning absolute configuration to molecules having maximum two chiral carbon atoms. E and Z stereodescriptors to geometrical isomers.

14.2. Diastereomers of disubstituted cycloalkanes (3 and 4 member rings.).

14.3. Resolution of enantiomers: chemical and chromatographic resolution.

14.4. Conformational analysis of - propane, 2-methylpropane, 2,2-dimethylpropane, n-butane.

15 **Structure Determination and Multistep Synthesis** 4L

Based on the reactions of aromatic compounds discussed above the following aspects should be highlighted:

15.1 Structure determination through a series of reactions.

15.2 Planning multistep synthesis of polysubstituted benzenes (up to 4 steps).

15L

UNIT VI 9L

16 **Green Chemistry**

16.1. **Green chemistry:** Definition, need. importance. 12 principles of green chemistry with relevant examples. Concepts and simple calculations on - Yield and Selectivity, E-factor, Atom economy.

16.2. Examples of green chemistry in industry.

(a) Green starting materials-commodity chemicals from glucose.

(b) Green reactions-halide free synthesis of aromatic amines.

(c) Green reagents-selective methylation using dimethyl carbonate.

(d) Green solvents-use of supercritical carbon dioxide.

(e) Green chemical products-synthesis of thermal polyaspartates.

(f) Green chemistry and catalysis - novel homogeneous, heterogeneous and enzymatic catalysts in industry.

(i) catalytic liquid phase selective hydrogenetion of nitrobenzene to p-aminophenol

(ii) liquid phase air oxidation of p-cresol to p-hydroxybenzaldehyde.

16.3 Future trends in green chemistry.

17 **Manufacture of Some bulk Chemicals Including flow diagrams)** 6L

Phenol, methanol (from syn gas), dodecylbenzene sulphonate, styrene, ethylene oxide.

Practical Syllabus

Practicals in Physical and Analytical chemistry

1] To study the kinetics of the reaction between potassium persulphate and potassium iodide at equal initial concentration.
2] To determine the partition coefficient of oxalic acid/ succinic acid between water and carbon tetrachloride.
3] To determine the amount of dissolved oxygen in the given water samples by Winkler's method.
4] To carry out assay of a commercial sample of aspirin using phenol red as the indicator.
5] To determine the amount of strong acid in the given solution by titration with a strong base conductometrically.
6] To verify Ostwald's dilution law for a weak acid conductometrically and hence to determine the dissociation constant of the weak acid.
7] To determine the amount of a strong acid present in the given solution by titration with a strong base using a pH meter.
8] To determine the dissociation constant of a weak acid using Henderson's equation by the method of incomplete titration with a strong base.
9] To determine ΔG^0 and equilibrium constant for the cell reaction in the cell set up with zinc and copper electrodes or with zinc and silver electrodes
10] To determine λ_{max} and molar extinction coefficient for potassium permanganate solution using a photometer

Practicals in Inorganic chemistry

Note: Safety measures in laboratory:

a. Handling of Chemicals and glassware
b. MSDs of Chemicals used in all the experiments covered in the syllabus.

1) **Gravimetric Exercises:**
i) Determination of Nickel as $Ni(dmg)_2$
ii) Barium as $BaCrO_4$, and
iii) Zinc as $Zn(NH_4)PO4$
Use of suitable sintered glass crucible, G3/G4 expected.

2) **Volumetric Exercises:**
i) Redox titration of iron(III) against potassium dichromate
ii)Water Analysis : Determination of total Hardness
iii)Determination of magnesium by complexometry (EDTA) titration.
(Standard solutions to be prepared by students).

3) Semi-micro Qualitative Analysis for the presence of four cations and two anions from:

Cations: Pb^{2+}, Cu^{2+}, Cd^{2+}, Fe^{3+}, Cr^{3+}, Al^{3+}, Mn^{2+}, Zn^{2+}, Ni^{2+}, Co^{2+}, Ca^{2+}, Ba^{2+}, Sr^{2} Mg^{2+}, NH_4^+, K^+.

Anions : Cl^-, Br^-, I^-, SO_4^{2-}, NO_3^-, NO_2^-, CO_3^{2-}, SO_3^{2-}, PO_4^{3-}, OAc^-, BO_3^{3-}, CrO_4^{2-}, $S_2O_3^{2-}$

(The use of hydrogen sulphide in any form should not be made).

Practicals in Organic Chemistry

Identification of an Organic Compound: The identification should be done through - preliminary tests, solubility, element detection, group tests, physical constant determination. The analysis should be done by micro-scale techniques.

For the identification of an Organic compound about 500mg of any compound with not more than two functional/neutral groups be given belonging to the following categories. Acids (carboxylic acids/sulphonic), phenols, aldehydes/ketones, alcohols, esters, amines (primary, secondary and tertiary), carbohydrates, ethers, hydrocarbons, halo/nitro hydrocarbons.

Derivative preparation: The exercise is aimed at imbibing the concept of derivative preparation as a method of identifying a given compound from a set of compounds having the same functional group. Based on the m.p. identify the given compounds looking at the chart. About 500mg of a suitable compound be given. The candidate will prepare the given derivative. No crystallization is expected. M.p. of the dried derivative should be taken and appropriate inference be drawn. The derivative preparation should involve one of the following reactions: (a) bromination (b) nitration (c) N'O-acylation/ benzoylation (d) hydrolysis (e) 2,4-DNP formation (f) oxidation (g) picrate

3. **Estimation of an Organic Compound:** The following estimations be given:
   a) estimation of acetone/formaldehyde by oxidation using iodine and alkali.
   b) Estimation of phenol/aniline by bromination using brominating solution.
   c) Estimation of acetamide/benzamide/ethyl acetate by hydrolysis.
   d) Equivalent weight of water soluble/water insoluble acid by alkalimetry and amine by acidimetry.

Notes:

(1) A minimum of 12 compounds be given for the identification; at least one from each of the categories in (ii) below.
(2) A minimum of three estimations be done by the candidates.
(3) For the estimations the concentrations and the quantities be reduced. For dilution a standard flask of 100ml capacity and for the transfer a pipette of 10ml capacity be used. The concentrations of the solutions be around 0.05N.

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Revised Syllabus in Chemistry
(Theory)
Second Year B. Sc. 2009 – 2010.

The scheme of examination for the revised course in Chemistry at the Second Year B. Sc. Theory Examination will be as follows.

Theory	Title	Examination	Maximum Marks	Maximum Marks after conversion
Paper-I	Physical and Analytical Chemistry	First Term	60	30
		Second Term	60	30
Paper-II	Inorganic and Industrial Chemistry	First Term	60	30
		Second Term	60	30
Paper - III	Organic and Industrial Chemistry.	First Term	60	30
		Second Term	60	30
Total Marks	Theory :			**180**

Scheme of Examination
S.Y.B.Sc. (Chemistry)
(Effective from 2009-10)

The examination will be conducted in three sessions of three hours each. With two sessions per day the examination will be of 1 ½ days.

Total Marks for practical examination are 120

Session- I
Physical and Analytical chemistry

The student will perform any one exercise from the list of the 10 exercises given

Total marks 30

Session –II
Inorganic chemistry
For the examination the candidate will perform two exercises.

Exercise –I **Qualitative Analysis** marks 15
Exercise –II **Gravimetric /volumetric** marks 15

Total Marks 30

Session –III
Organic chemistry
Exercise-I **Identification/ Estimation of Organic Compound** **Marks 22**
Exercise -II **Derivative Preparation**

Quality	**Marks 03**	
Inference	**Marks 02**	**Total Marks 08**
Reaction	**Mark 01**	
Melting point	**Marks 02**	

Total Marks 30

Viva- Voce examination

Physical exercise	**Marks 05**
Inorganic exercise	**Marks 05**
Organic exercise	**Marks 05**

Total Marks 15

Journal **Marks 15**

Total Marks 120

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