UNIVERSITY OF THE PUNJAB

NOTIFICATION

It is hereby notified that the Syndicate at its meeting held on 11-10-2008 has approved the recommendations of the Academic Council regarding Syllabi & Courses of Reading in the subject of Chemistry (Elective) for B.Sc. (Pass Course) Examination w.e.f. the session 2005-2007.

The Syllabi & Courses of Reading in the subject of Chemistry (Elective) for B.Sc. (Pass Course) Examination w.e.f. the session 2005-2007 is attached herewith, vide Annexure 'A'.

Admin Block,
QUAID-E-AZAM CAMPUS,
Lahore.

No. D/410/ Acad.

Copy of the above is forwarded to the following for information and further action:

1. The Dean, Faculty of Science.
2. The Convener,
   Board of Studies in Chemistry
3. The Director, Institute of Chemistry
4. Members of Board of Studies in Chemistry.
5. Controller of Examinations
6. Deputy Controller (Computer)
7. Deputy Controller (Examination)
8. Deputy Controller (Conduct)
9. A.R. (Statutes)
10. Secretary to the Vice-Chancellor
11. Secretary to the Registrar
12. Record Lifter

Sd/-
Prof. Dr. Muhammad Naeem Khan
Registrar


Muhammad Azam
Deputy Registrar (Academic) for Registrar
SYLLABUS FOR B.Sc.CHEMISTRY

Duration of Programme : Present: 2 Years

Entry Requirement : F.Sc. (Pre-engineering/Pre-medical)

Open Merit

Number of Courses : 3 courses (Theory + Practical)

Total Marks : 200

OUTLINES OF TESTS

Paper 'A' Physical Chemistry (Written) .. .. .. 50
Paper 'B' Inorganic Chemistry (Written) .. .. .. 50
Paper 'C' Organic Chemistry (Written) .. .. .. 50

Practicals (for three days, Four hours duration each day as detailed below):

Paper 'A' Physical Chemistry (Practical) .. .. .. 16
Paper 'B' Inorganic Chemistry (Practical) .. .. .. 17
Paper 'C' Organic Chemistry (Practical) .. .. .. 17

Total:- 200

Medium of Instructions & Examination : English
1. STATES OF MATTER

i) GASES

Law of equipartition of energy, Collision diameter, collision number, collision frequency and mean free path; Viscosities of gases, measurements, effect of temperature and pressure on viscosities of gases; Critical phenomenon of gases and experimental determination of P_c, V_c and T_c; Concept of molecular velocities of gases according to Maxwell’s distribution law and comparison of various velocities.

ii) LIQUIDS

The properties of liquids like surface tension, viscosity, refractive index and dipole moment; Parachor, refractive index and molar refraction as additive and constitutive properties; Measurement of refractive index and dipole moment; Magnetic susceptibility and its measurement by Gouy’s balance.

iii) SOLIDS

Symmetry operations and Bravis lattices; Concept of X-ray diffraction, Bragg’s equation and crystal structure analysis; Powder method of crystal structure analysis; X-ray crystallography of sodium chloride crystal; Heat capacities of solids.

2. QUANTUM MECHANICS AND ATOMIC STRUCTURE

Elementary treatment of Compton effect and photoelectric effect; Brief discussion of result of Bohr’s Model and its defects; Sommerfeld’s modification and evolution of azimuthal quantum number; Dual nature of matter, verification of dual nature by Davisson and Germer’s experiment; Details of Heisenberg’s uncertainty principle; Postulates of quantum mechanics; Brief introduction of operators; Derivation of time independent Schrödinger wave equation in terms of polar coordinates and derivation of principle quantum number; Energy equation for free motion of particle in one-dimensional box; Eigen values and Eigen functions; normalization of wave function; Probability functions, radial distribution, probability density functions.

3. CHEMICAL THERMODYNAMICS

Heat capacity as C_p and C_v, Difference in C_p and C_v and ratio of C_p and C_v towards atomicity; Temperature dependence of heat capacities; Quantitative effect of temperature over enthalpy change and internal energy change; Types of thermodynamical processes, Isothermal reversible expansion of ideal gases; Adiabatic process of ideal gases; Second law of thermodynamics, Carnot cycle, efficiency of heat engine and concept of entropy; Thermodynamic scale of temperature entropy for phase transition, spontaneity and reversibility; Entropy change in reversible and irreversible processes; Temperature dependence of entropy, Variation of entropy with pressure and volume; Concept of free energy; Derivation of Gibbs and Helmholtz equation; Standard free energy of formation; Partial molar quantities, Chemical potential, variation of chemical potential with pressure and temperature, fugacity; Thermodynamic of equilibrium, Reaction isochore; Clausius-Clapeyron equation; Molecular basis of entropy and probability.
4. CHEMICAL EQUILIBRIUM

Concept of chemical equilibrium, Derivation of relationship between $K_c$, $K_p$, $K_x$ and $K_n$; Application of law of mass action to homogenous equilibria to explain the effect of volume and pressure change on degree of dissociation of certain important reactions as dissociation of $PCl_5$, $N_2O_4$ and $NH_3$; Application of law of mass action to heterogeneous equilibria; Effect of adding inert gas to gaseous system at equilibrium; Quantitative effect of temperature on chemical equilibrium.

5. CHEMICAL KINETICS

Derivation of kinetic expression of zero order, first order, second order (with same and different concentration) and third order reactions (with same concentrations) with suitable examples; Equation for half life periods and determination of rate constants; Methods of measurements of order of reactions giving examples with different techniques; Derivation of Arrhenius equation and measurements of Arrhenius parameters; Measurement of slopes of Arrhenius plots for some important reactions; Bimolecular collision theory of reaction rates and its failures; Collision theory of uni-molecular, gas phase reactions (Lindemann mechanism); Introduction to transition state theory of reaction rates.

6. SOLUTIONS AND COLLOIDS

Thermodynamic derivation of colligate properties as lowering of vapor pressure, elevation of boiling point, depression of freezing point; Relationship between lowering of vapor pressure with $ATb$ and $ATf$; Osmotic pressure and their determination; Concept of semi permeable membrane; Isotonic solution, theory of Osmosis, Laws of osmotic pressure, relationship between vapor pressure and osmotic pressure; Abnormal colligative properties describing association and dissociation of solutes; Fractional distillation and idea of azotropes in detail; Nernst distribution law, its limitations and its application in chemistry; Concept of colloids; Classification of colloids; Preparation of colloids, their properties with reference to dialysis, electrodialysis, sedimentation, precipitation, ultra filtrations; Suspensions and gels; Tyndal cone effect; Macromolecules and micelles.

7. ELECTROCHEMISTRY

Electrolytic conduction and its measurement; Specific, equivalent and molar conductance; Determination of resistance; Cell content, conductance ratio, conduction of strong and weak electrolytes; Ionic mobilities and their determination; Kohlrausch’s law and its applications; Faraday’s law (first and second) and their significance; Transport number, Hittorf’s rule; Determination of transference number by Hittorf’s method. Applications of conductance measurement; EMF of the chemical cells; Electrode potentials and its measurement with reference to Weston standard, glass electrode, calomel electrode and quinhydrone electrode; Nernst equation, thermodynamics of cells; Concentration of cells with liquid junction and without liquid junction.

8. SURFACE CHEMISTRY

Introduction to adsorption; Difference between physical and chemical adsorption; Adsorption of gases by solids; Different types of adsorption isotherms with special reference to Langmuir adsorption isotherm and its applications; Freundlich adsorption isotherm giving some important applications; Brief introduction to catalysis; Theories of catalysis; Activation energy for catalyzed reactions; Kinetics of enzyme catalysis.
1. Determination of percentage composition by surface tension, viscosity and refractive index method.

2. Determination of heat of solution for solids and liquids.

3. Quantitative measurement of coloured salt of KMnO₄, K₂Cr₂O₇ in colorimeter

4. Verification of first law of Faraday by electroplating of CuSO₄, NiSO₄, Cr₂(SO₄)₃, Ag⁺ CN⁻ and Au⁺ CN⁻

5. Conductimetric and potentiometric titration using conductivity bridge and pH meter.

6. Measurement of reduction potential using of Zn, Cu, Ag, Al etc., by using calomel electrode.

7. Study of first order reaction:
   a) Study of hydrolysis of methylacetate
   b) Measurement of rate constant

8. Verification of Langmuir Isotherm.

9. Thin layer chromatography

10. Measurement of molecular weight by Depression of freezing point.

11. Determination of transition temperature of Na₂SO₄ 10 H₂O: Na₂CO₃ 10 H₂O; MgSO₄ 7 H₂O

RECOMMENDED BOOKS:


9. Francis Marion Miller "Structure and Dynamics"


11. Denbigh, "The Principle of Chemical Equilibrium"

12. IRA. N. Levine fourth edition "Physical Chemistry"

13. B.H. Mahan, "Elementary Chemical Thermodynamics"

14. E-F Caidin, "An Introduction of Chemical Thermodynamic"

15. Alberty and Danials, "Physical Chemistry"

16. Castellan, "Physical Chemistry"

17. Laidler & Melser "Physical Chemistry"

18. Sample Glass Tone "Introduction of Electro Chemistry"


20. Milner "Electrochemistry"


22. H.S. Harned and B.B. Owen "The Physical Chemistry of Electrolytic Solution"

23. Friemental "Chemistry in Action"

FOR PRACTICALS:


1. **Periodicity**

   Modern periodic table; Similarities and differences in first row elements; their diagonal and vertical relationship with other elements; electronegativity of elements (Pauling and Mulliken scales); Polarizability and polarizing power of ions; Periodicity in the properties of transition and inner transition elements.

2. **Theories of Chemical Bonding**

   Nature and types of Chemical Bonding. Modern concept of Valence Bond Theory (VBT), Molecular Orbital Theory (MOT) and their applications to Homo and hetero di-and polyatomic inorganic molecules, explaining the conventional and modified MO diagrams. Valence Shell Electron Pair Repulsion Theory (VSEPR), explaining the shapes of inorganic molecules (i.e. \( \text{AB}_2 \), \( \text{AB}_3 \), \( \text{AB}_2\text{E} \), \( \text{AB}_4 \), \( \text{AB}_2\text{E}_2 \), \( \text{AB}_5 \), \( \text{AB}_4\text{E} \), \( \text{AB}_3\text{E}_2 \), \( \text{AB}_5 \), \( \text{AB}_2\text{E}_3 \), \( \text{AB}_6 \), \( \text{AB}_4\text{E}_2 \)) and directed valence theory (Hybridization). Metallic bonds (detailed concept).

3. **Acid-Base Concept**


4. **Chemistry of d-Block Elements**

   Electronic configuration and oxidation states of transition elements. Metallurgy of chromium, nickel and copper. Theories of coordination compounds, Valence Bond Theory (VBT), Molecular Orbital Theory (MOT) and Crystal Field Theory (CFT) for tetrahedral and octahedral complexes. Nomenclature, Isomerism in coordination compounds. Chelates. Application of coordination compounds.

5. **Nuclear Chemistry**

   Phenomena of radioactivity, Natural radioactivity, radioactive disintegration series, rate of disintegration and half life period, mass defect and binding energy, nuclear stability, measurement of nuclear radiation (Wilson Cloud Chamber and Geiger-Muller Counter), Carbon dating; Artificial radioactivity and Nuclear Transformations, Nuclear reactions (Fission and Fusion), Uses of radioactive isotopes, Biological effect of Nuclear radiation.

6. **Solvent Extraction and Chromatographic Techniques**

   Basis of solvent extraction process; Distribution Law and Distribution co-efficient; Simple extraction, Double extraction and multiple extraction systems; applications of solvent extraction in chemistry and industry. Basic principle of chromatographic techniques; Classifications of Chromatographic techniques on the basis of mobile and stationary phases; introduction to column and thin layer chromatography.
7. **Evaluation of Analytical Data and Essentials of Chemical Analysis**

Some fundamental concepts like mole, activity and activity co-efficient; Concepts of mean, median, accuracy, precision, significant figures; Standard deviation; Relative standard deviation. Law of mass action and its applications; precipitation and solubility product; common ion effect; Co-precipitation, fractional precipitation.

8. **Spectroscopy**

Electromagnetic radiation and its interaction with matter; Nature of different transitions possible in atoms and molecules; Electronic, vibrational, rotational and other possible transitions by absorption of radiation by molecules and atoms. Development of spectroscopic analytical techniques employing various transitions. Classification of spectroscopic techniques on the basis of type of radiation, phenomenon occurring and the nature of the matter. Basic introduction to atomic and molecular spectroscopic techniques including flame emission, spectrophotometry, UV and IR spectroscopy.

9. **Chemical Industries**

Glass, Soda ash & Soap.
PRACTICAL B.Sc. CHEMISTRY (INORGANIC)
PAPER ‘B’

PREPARATIONS
1. Ferric Alum
2. Potassium tri-oxalato aluminate
3. Sodium Thiosulfate
4. Amm. Copper (II) Sulphate

PAPER CHROMATOGRAPHY
Separation & identification of Cations/Basic radicals of Group I, II.A, II.B & III. Also calculate their Rf values.

ARGENTOMETRY

MOHR’S METHOD
1. Determine the %age purity of NaCl (Rock Salt)
2. Determine the amount of NaCl in the commercial sample of soda ash.

VOLTAIR’S METHOD
1. Determination of %age purity of HCl.
2. Determination of silver in the given sample, using KSCN or NH₄SCN.

IODOMETRY
1. Determination of iodide and KI in the given sample solution.
2. Standardization of Na₂S₂O₃.5H₂O solution.
3. Determination of amount/dm³ of Cu²⁺ and CuSO₄.5H₂O using Na₂S₂O₃ and KI.
4. Determination of no. of water molecules (v) in CuSO₄. xH₂O iodometrically.

REDOX TITRATIONS (By using both internal and external indicators)
1. Determination of amount/dm³ of FeSO₄.7H₂O with K₂Cr₂O₇.
2. Determination of %age purity of K₂Cr₂O₇ by using standard solution of Mohr’s salt.
3. Determination of no. of water molecules (v) in FeSO₄. xH₂O using K₂Cr₂O₇.
4. Determination of Ce⁴⁺ by KmnO₄.
5. Determination of %age of Iron in Ferric Alum (NH₄)₂SO₄,Fe₃(SO₄)₂.24H₂O using K₂Cr₂O₇.
COMPLEXOMETRY

1. Standardization of EDTA solution by Magnesium/Zinc Sulfate solution.
2. Find out the amount of Ca$^{2+}$ in the given sample of marble (lime stone).
3. Determination of Ca$^{2+}$ and Mg$^{2+}$ in the sample by using EDTA.

RECOMMENDED BOOKS

SYLLABUS FOR B.Sc. ORGANIC CHEMISTRY
PAPER ‘C’

1. Basic Concepts in Organic Chemistry
Hybridization of orbitals of carbon atoms in alkanes, alkenes, alkynes and arenes. Hybridization of orbitals of nitrogen, oxygen and sulfur atoms in various functional groups. Localized and delocalized chemical bonding; Conjugation and hyper conjugation; Resonance, rules of resonance, resonance energy, resonance hybrid, factor effecting the resonance; Inductive effect, Applications of inductive effect and resonance on various properties of organic compounds; Steric effect and its applications, Hydrogen bonding and its effects on various properties of organic compounds, Tautomerism.

2. Nomenclature of Organic Compounds
Nomenclature of alkanes, alkenes, alkynes, cycloalkanes, bicycloalkanes, spiroalkanes, monofunctional and polyfunctional derivatives of open chain and cyclic compounds, polysubstituted benzenes, polycyclic hydrocarbons such as naphthalene, anthracene, phenanthrene and their derivatives, and heterocyclic compounds.

3. Hydrocarbons

a) Alkanes and Cycloalkanes
Preparation of alkanes from alkyl halides, coupling of alkyl halide and alkylborenes, reduction of carbonyl compounds, Kolbe’s electrosynthesis, Corey-House-Synthesis, Hydrogenation of alkanes and alkenes.
Reactions of alkanes with halogens, their mechanism and comparison of reactivities of halogens; combustion, isomerization, nitration and sulfonation.
Preparations of cycloalkanes by Freund synthesis, Hydrogenation of cyclic alkenes, Structure and stability of cycloalkanes; Reaction of cycloalkanes.

b) Alkenes and Alkynes
Preparation of alkenes from elimination reaction of alkyl halides and alcohols; Mechanism and orientation of eliminations; Dehalogenation of vicinal dihalides with mechanism, Pyrolytic eliminations.
Reactions of alkenes: relative stability and reactivity, addition of halogens, additions of halogen acids and the rules governing these reactions, hydration reactions, oxidation reactions including epoxidation and hydroxylation, polymerization; Simon-Smith and Diels-Alder reactions.
Preparation of alkynes by carbide process, dehydrohalogenation of dialkylides and alkylation of terminal alkynes.
Reactions of alkynes: addition reactions with mechanisms, hydration reactions, oxidation, reduction, hydroboration, formation of metal acetylides, polymerization (linear and closed chain)

c) Aromatic Hydrocarbons
Structure of benzene, Resonance energy of benzene, Aromaticity, Criteria for aromaticity, Evidences of aromaticity; Natural sources of aromatic hydrocarbons; Preparation of aromatic hydrocarbons by different methods.
Reaction of aromatic hydrocarbons: electrophilic aromatic substitution reactions i.e. nitration, halogenation, Friedel-Crafts reaction and its limitations, sulfonation; Orientation and reactivity of substituted benzenes; Nucleophilic aromatic substitution reactions; reaction such as addition, hydrogenation, Birch reduction, and oxidation reactions of side chains.


4. Isomerism

Conformational isomerism: conformational analysis of ethane, n-butane, cyclohexane, mono- and di-substituted cyclohexanes.

Optical isomerism: optical activity; chirality and optical activity; enantiomers, diastereomers; racemates and their resolution; D, L and R, S conventions; Optical Isomerism in cyclohexanes, bipheyis and allenes

Geometrical isomerism: cis and trans isomers; E-Z convention; determination of configuration of the isomers; inter-conversion of geometrical isomers; geometrical isomerism in cyclic compounds.

5. Alkyl halides

Preparation of alkyl halides from alcohols, carboxylic acids;

Chemical reactions: Aliphatic nucleophilic substitution reactions, SN_{1} and SN_{2} mechanism, effects of the nature of substrate, attacking nucleophile, leaving group and the nature of solvent. Elimination reactions, E_{1} and E_{2} mechanisms, orientation of elimination (Hoffmann and Sytzeff rules).

Grignard Reagents; synthesis, structure, and reactions with active hydrogen compounds, carbonyl compounds such as aldehydes, ketones, esters, acid halides and CO_{2}; reaction with nitriles, ethylene oxide, sulphur and oxygen.

5. Chemistry Hydroxyl Group containing Compounds and Ethers

Alcohols: Physical properties; Preparation of alcohols by the reduction of carbonyl compound; Reactions of alcohol with metals, organic and inorganic acids; Oxidation of alcohols; Distinction between primary, secondary and tertiary alcohols; Preparation of dialls, triols and their important reactions and uses.

Phenols: Physical properties; Synthesis of phenols; Reactions of phenols such as acylation, Friedel-Crafts reaction, nitration, sulfonation, carbonation, formylation and diazo coupling.

Ethers: Physical properties; Preparation of ether from alcohols, alkyl halides and alkenes; Reactions of ethers. Brief introduction of crown ethers and polyethers.

7. Chemistry of Carbonyl Compounds

Preparation of aldehydes and ketones by pyrolysis of calcium salts of acids, acylation of alkenes and arenes, reduction of acid halides and nitriles.
Physical properties of aldehydes and ketones; Structure and reactivity of carbonyl group; Comparison of the reactivity of aldehydes and ketones; Nucleophilic additions of water, alcohols, ammonia and its derivatives, hydrogen cyanide, bisulfite, reduction and oxidation reactions; Aldol condensation and related reactions, Cannizaro's reaction, Wittig reaction, oxidation reactions, Chemical tests of aldehydes and ketones.

8. Chemistry of Carboxylic Acids and Their Derivatives

Physical properties of carboxylic acids; Effects of different parameters on the acid strengths of aliphatic and aromatic carboxylic acids. Chemical properties, like salt formation nucleophilic acyl substitution, reduction of carboxylic acids, decarboxylation, Hunsdiecker reaction, Kochi reaction, substitution at α-carbon. Preparations, properties and reactions of acids chlorides, acids anhydrides, amides, cyanides, and esters: Maionic and acetoacetic esters syntheses.

9. Chemistry of Amines

Preparations of primary, secondary and tertiary amines by alkylation of NH₂; Gabriel synthesis; Reductive amination; Reductions of amides, nitriles and the nitro compounds.

Physical properties of amines, Basicity of amines and effects of different parameters on basic strength of amines; Reactions of amines such as salt formation, alkylation (including exhaustive methylation and Hofmann degradation), acylation and sulfonation; Reaction with nitrous acid, Formation of isonitriles. Synthesis and applications of arenediazonium salts, Synthesis and applications of quaternary ammonium salts.

Synthesis of pyrrole and its derivatives from acetylene, succinimide and furan, Paal-Knorr synthesis, Knorr pyrrole synthesis and Hantzsch synthesis. Basicity of pyrrole, its aromatic character and stability. Reaction of pyrrole i.e. salt formation, reduction, electrophilic substitution reactions and polymerization.

1. **Compound Analysis**

Identification of Organic Compounds containing only one functional group with special emphasis on compounds containing following functional groups.
- COOH, -OH, C=O, -NH₂, and -CONH₂

2. **Preparation of Organic compounds**

Preparation and techniques of purification of tribromophenol, Nirobenzene, Aspirin, Ethyl benzoate and Benzoic acid from Toluene, Butyl chloride, Acetanilide.

3. **Basic Experimental techniques used in organic chemistry**

1. Filtration
2. Simple and fractional distillation
3. Solvent extraction
4. Sublimation
5. Re-crystallization
6. Column Chromatography

4. **Estimations (volumetric)**

1. Determination of molecular weight of a carboxylic acid.
2. Estimation of amide group and glucose.

**RECOMMENDED BOOKS**