

CHEMISTRY

The following Syllabus for Chemistry B.Sc. Part-1 (III Year) & Part-II (IV Year) has been prepared in accordance with the guidelines given by the Higher Education Commission of Pakistan.

Scheme of Study

B.Sc. Part-I(for 3rd Year)

Paper I	Organic Chemistry	Marks: 38	Time: 3 Hours
Paper II	Applied Chemistry	Marks: 37	Time: 3 Hours
Paper V	Practical	Marks: 25	Time: 4 Hours
Total Marks: 100			

B.Sc. Part-II (For 4th Year)

Paper III	Physical Chemistry	Marks: 38	Time: 3 Hours
Paper IV	Inorganic Chemistry	Marks: 37	Time: 3 Hours
Paper VI	Practical	Marks: 25	Time: 4 Hours
Total marks 100			

NOTE: In each Part

Q.No.1: Objective Compulsory Paper I, Paper III = 6 marks & Paper-II.
Paper IV = 5 marks

Section (I) Four Questions (8 marks)

Section (II) Four Questions (8 marks)

Attempt Two Questions from each section. Every Question carries 8 marks.

B.Sc. Part-I

Paper I

- ORGANIC CHEMISTRY SECTION-I

1. BASIC CONCEPTS IN CHEMICAL BONDING

Localised and delocalised chemical bonding, rules of resonance, resonance effect. Steric inhibition of resonance, resonance energy. inductive effect. Dipole moment and its applications to structure and reactivity of organic compounds. Hyper conjugation, Tautomerism.

2. HYDROCARBONS

ALKANES. Nomenclature. Preparation from (i) alkyl halides (ii) alcohols (iii) carbonyl compounds and (iv) carboxylic acids.

REACTIONS Halogenation, nitration, sulphonation, pyrolysis and dehydrogenation
ALKENES Preparation from (i) Pyrolysis of esters. (ii) Chugaev reaction (iii) Cope reaction (iv) Hofmann reaction (v) Wittig reaction

REACTIONS. Hydrogenation and its application, halogenation and hydrohalogenation. Markownikoff and Anti-Markownikoff addition, hydration, hydroboration, different ways of oxidation. Isomerization. Tests for the identification of double bond.

ALKYNES Preparation. Dehydrohalogenation, of dihalides, alkylation of acetylene.
REACTIONS Partial hydrogenation. halogenation, addition of H-X , HCN , CH_3COOH & H_2O , oxidation of alkynes having acidic hydrogen Comparison of the reactivity of alkenes and alkynes.

CYCLO-ALKANES Preparation by carbene addition, Perkin reaction, Diels-Alder reaction: Simon-Smith reaction. Reactions of small sized cyclo alkanes, structure of small sized cyclo alkanes.

3. AROMATIC HYDROCARBONS

Nomenclature. Historical development of structure of benzene, aromaticity (Huckle's Rule) Aromatic electrophilic substitution w.r.t. halogenation, nitration, sulphonation. Friedal-Craft reaction, and formylation. Orientation and reactivity.

4. ISOMERISM

Geometrical isomerism: Determination of configuration of geometrical isomerism, Z. E. convention and cis, trans isomerism in compounds containing two double bonds; Optical isomerism: Optical activity, chirality and optical activity, racemisation and resolution of racemic mixtures, R, S notation, diastereoisomers. Conformational isomerism: Brief introduction

to conformation of ethane, n-butane and cyclohexane.

SECTION —II

5 ALKYLHALIDES

Nomenclature. Preparation and reactions of alkyl halides with special reference to nucleophilic substitution and elimination reaction, factors affecting nucleophilic substitution and elimination reactions. Grignard's Reagent, preparation, structure and synthetic application.

6 CHEMISTRY OF HYDROXYL GROUP

Nomenclature. Preparation, physical properties & reactions of alcohols and phenols. Uses

of hydroxyl compounds. Distinction between Pri. Sec. & Ter. Alcohols.

7 CHEMISTRY OF CARBONYL COMPOUNDS

Nomenclature. Preparation of aldehydes from (i) alcohols (ii) acid chlorides (iii) calcium salts of carboxylic acid (iv) methyl benzene. Preparation of Ketones, Oppenour oxidation, Friedal-Crafts acylation, pinacol rearrangement, hydration of alkynes, oxidative cleavage of carbon carbon double bond. Reactions. Nucleophilic addition reaction, reduction of aldehyde & ketones. Oxidation of aldehydes and ketones, reactions due to a hydrogen atom of aldehydes and ketones, haloform reaction, aldol condensation, cannizaro reaction. Uses of carbonyl compounds.

8 CHEMISTRY OF CARBOXYLIC ACIDS AND THEIR DERIVATIVES

Nomenclature. Preparation, properties and reactions of carboxylic acids and their derivatives like esters, amides. acid anhydrides.

9 HETEROCYCLIC COMPOUNDS

Nomenclature. Methods of preparation of pyrrol and pyridine. Their aromatic character And comparison with benzene. important reactions of pyrrol and pyridine.

Total Hours = 60

Books Recommended:

- 1 Younas M., Text Book of Organic Chemistry, Ilrni Kutab Khana, Lahore.
- 2 Rehman, A., Text Book of Organic Chemistry, Carvan Book House, Lahore.
- 3 March, J., Advanced Organic Chemistry, Wiley, New York.
- 4 Pine, S.H., Organic Chemistry, McGraw-Hill, New York.
- 5 Skyes, P., A Guide Book to Mechanism in Organic Chemistry, Longman, London.
- 6 Solomons, T.W.G., Fundamentals of Organic Chemistry, Wiley New York.
- 7 Vogel, A.L., .A Text Book of Practical Organic Chemistry, Longman, London.
Clarke, H.T. and a Haynes., A hand Book of Or ganic Analysis, Edward Arnold London.
- 9 Mann, F.G and B.C. Saunders. Practical Organic Chemistry, Longman London.
- 10 Shiner, R. L., D.Y. Curtin, R.C. Fuson, and T.C. Morrill, The Systematic Identification of Organic Compounds, Wiley New Yor---
- 11 Rehman, A., Experimental Organic Chemistry, The Carvan Book House Lahore.

12 Morrison R.T. and RN. Boyd, Organic Chemistry, Allyn and Bacon, London.

13 Advanced Practical Chemistry Part-I & Part-II Ilmi Kitab Khana by Dr. M. Zafar Iqbal,
A. Rehman Ch.

B.Sc. Part-I Paper II

APPLIED CHEMISTRY

SECTION-I

1:- CHROMATOGRAPHY.

Paper Chromatography, Methodology, Rf Value, application to some colored ions, solvent specifications for some separations Thin layer chromatography. Preparation of thin layers, methodology and applications.

2:- SPECTROSCOPY

UN. and Visible, Beer-Lambert Law. Absorption and transmission of light, instrumentation. methodology and applications to solution to determine -maxum and concentration. Infra Red, Instrumentation, methodology. Identification of functional groups in I.R spectra.

3:- COLLOIDS

Concept of colloids, Macromolecules, Micelles. Concept of colloidal solution, its preparation, purification, properties with refer ence to Tyndal effect, electrophoresis. Applications of colloids.

4:- ELECTRO CHEMISTRY

Equivalent and molar-conductance. Dependence of conductance on solvent and temperature. Kohlrauch's law and its application. Measurement of conductance of strong and weak electrolytes; degree of dissociation. Dependence of degree of dissociation on dilution(Ostwald dilution law) Dissociation constant. Calculation of PH for a typical weak acids. Transport numbers and their determination by moving boundary method and Hittorf s method.

5:-NUCLEAR CHEMISTRY

Types of nuclear radiations. Detection and measurement of radioactivity. Stable and unstable isotopes. Artificial nuclear transformations. Application of radioactive isotopes nuclear hazards and safety measures G.M counter and cloud chamber. Nuclear fission end fusion reactions. Brief description of nuclear reactors.

SECTION -II

1:-INTRODUCTION TO MODERN MATERIALS

Inorganic polymers, Silicones, Phosphazenes (Preparation and applications). Organic polymers; phenol formaldehyde, urea formaldehyde, melamine formaldehyde(preparation and uses) Ceramics, Engineering ceramics, ceramic composite, their applications Fiber Glass. Liquid crystals

2:- DYES

Dyes General introduction, cause of color, classification, Manufacture of dyes and Azo Dyes.

3:- INDUSTRIES

Industries of CEMENT, GLASS SUGAR. NITROGEN AND PHOSPHORUS based fertilizers.

4:- METALLURGY

Copper. Silver Chromium.

5:- BIOTECHNOLOGY.

Fermentation as biochemical process, commercial manufacture of absolute alcohol, vinegar.

Total Hours = 60

Books Recommended

- 1 Marson S.H. & B. Jerome. "Fundamentals of Physical Chemistry". Macruthan Publishing co. inc. New York (also Published by National Book Foundation)
2. Heald C. & A.C.K. smith. Applied Physical Chemistry English Language.
3. Shriver, D.F., P.W. Atkins and C.H. Langord," Inorganic Chemistr y". Oxford, 2^{ld} Edition (1984).
4. Sharpe, A.G., "Inorganic Chemistry" Longman,3 Edition(1992)
5. Younas, M. Organic Spectroscopy, A.H. Publisher, Lahore,
6. Text Book of Physical Chemistry for B.Sc. students by Ah Mohammad and Ghulam Rasool Chudhary, Ameen Publishers, Urdu Bazar Lahore.
- 7.Text Book of Physical Chemistry for B.Sc. students by G. Nabi, Publishers; Ilmi Kitab Khana— Urdu Bazar, Lahore. Physical Chemistry by W.J. Moore, Longman Scientific and Technical.
9. Principles of Physical Chemistry by Marron and Pruffon, The Macmillan Company.
10. Physical Chemistry by Atkins, Oxford University Press.

11. Roger's Industrial Chemistry, Von Norstand Co. N.Y.

Practical's Organic & Applied Chemistry

Time of Exam: 4 Hours

Maximum Marks: 25

Q.No.1 Organic Chemistry practical = 10

Q.No.2 Applied Chemistry Practical = 10

Q.No.3 Viva = 03

Q.No.4 Practical Note Books = 02

Note: Relevant Books/Note Books etc. not allowed for help.

Paper (V) B.Sc. Part-I Organic Chemistry Practicals

Practical Syllabus

1. Qualitative Organic Analysis:

Systematic identification of organic compounds containing groups like COOH, OH, NH, and C=O

Preparation and Techniques of Purification:

Preparation of simple organic compounds viz., t-butyl chloride, benzoic acid, tribromophenol, purification techniques viz solvent extraction, distillation and recrystallisation.

Books Recommended

1. Vogel A.I. "A Text Book of Organic Analysis Edward Arnold, London.
2. Mann, F. G. and B.C. Saunders. Practical Organic Chemistry Longman London.
3. Clarke, H.T. and D Haynes A Hand book of Organic Analysis Edward Arnold London.

Paper V B.Sc. Part-I Applied Chemistry Practicals

Practical Syllabus

1. Identification of cations by paper chromatography.

$(Cu^{+2} + Fe^{+2}), (Al^{+3} + Fe^{+3}), (Cd^{+2} + Pb^{+2})$

Preparation of Indigo dye.

3. Preparation of urea-formaldehyde.

4. Preparation of Bakelite.

5. Separation of mixture of Phenol and natural products by chromatography.

Book Recommended .

Riegel's Handbook of Industrial Chemistry. Von Norstand
Reeinhold Co. N.Y.

2. Vogel AI "A Text Book of Organic Analysis Edward Arnold, London.
3. Mann, F. G. and B.C. Saunders. Practical Organic Chemistry Longman London.

B.Sc. Physical Chemistry Part-II (Written)

Paper III

Section-I

Maximum Marks = 38 Time of Exam = 3 Hours

Total Study Hours = 60 Study Hours = 30

SECTION-I

1. ELEMENTARY MATHEMATICS: (8 Hours)
 - (a) Idea of equation of straight line with examples of mathematical equations of physical chemistry.
 - (ii) Limits (continuous and discontinuous) Exponential and Trigonometric Functions.
 - (iii) Binomial expansion with examples from chemistry
 - (iv) Partial fractions of algebraic function.
 - (v) Concept of differentiation of algebraic and trigonometric function
 - (vi) Concept of exact and partial differential. Formulae of differentiation and integration.
 - (vii) Basic concept of logarithm
 - (viii) Elementary treatment of operators and complex number.

2. PHYSICAL STATES OF MATTER: (14 Hours)

- (a) GASES: (6 Hours)
 - (i) Review of Gas and its Laws.
 - (ii) Collision diameter, collision frequency and mean free path.
 - (iii) Principle of equipartition of energy
 - (iv) Non ideal behaviour of real gases. Vanderwaal's equation of state. Critical phenomenon and determination of critical constants. Derivation of critical values of temperature (T,) pressure (P,) and Volume (V,). The Law of corresponding state. Experimental determination of critical temperature.

T (4 Hours)

Brief concept of Vapour pressure, surface tension, viscosity, solution viscosity Parachor, and their applications, Refractive index, Measurement of refractive index

by Abbe's and pulfrich refractometer. Molar refractions and its applications.

Molecular polarization, Dipole moment and its determination and applications.

(c) **SOLIDS.** (4 Hours)

Crystal lattice, unit cell, symmetry operations and Bravais lattice

Concept of X-rays diffraction, Bragg's equation and methods of crystal structure analysis. X-rays crystallography of sodium chloride crystal.

3. **QUANTUM MECHANICS AND ATOMIC STRUCTURE:** (8 Hours)

- Introduction to wave theory of light. Basic idea of wave, photon and Quanta. Standing waves.
- Plank's quantum theory. Elementary treatment of Compton effect, photoelectric effect
- Dual nature of matter. Davisson and Gernner experiment. Wave associated with micro and macroscopic particles.
- Heisenberg's uncertainty principle and its empirical formulae Postulates of quantum mechanics,
- Schrodinger wave equation & its various forms.
- Energy equation for free motion of the particle in one dimensional box. Eigen values and Eigen functions, concept of probability- and operators. Normalization of wave function. Probability function. Probability density function and probability curves for 1s, 2s, 2p, 3p orbitals.

Section-II Study Hours = 30

I. CHEMICAL EQUILIBRIUM: (5 Hours)

- (a) Introduction: concept of chemical equilibrium & Law of mass action.
- (b) Derivation of relationship between K_c , K_p ,... K_x and K_n .
- (c) Application of Law of Mass action to Homogenous and Hetrogenous equilibria. Le Chatelier's principle and the effects of variables e.g., temperature, concentration, pressure on equilibrium.

2. CHEMICAL KINETICS: (8 Hours)

1. Elementary treatment of chemical kinetics. Idea of order, molecularity & rate of reaction.
2. Derivation of Kinetic expression for zero order, first order, second order (with same and different concentration) with examples. Determination of rate constant

Determination of Order of reaction (Cliff. Method) with examples.

3. Arrhenius equation, describing effect of temperature on reaction rate. Arrhenius plots. Measurements of Arrhenius parameters.
4. Bimolecular collision. Collision theory of reaction rates. Causes of its failure with example, unimolecular reaction in gas phase. (Lindemann's Mechanism) Transition state theory of reaction rate.

3. CHEMICAL THERMODYNAMICS: (12 Hours)

- (a) Thermodynamic terms, Internal energy, Enthalpy, State & State function Heat capacity C_p and C_v , difference & ratio of C_p and C_v , Atomicity of gases from ratio of C_p & C_v . Temperature dependence of heat capacities of substances. Heat of reaction, effect of temperature on heat of reaction (Kirchoff's equation)
- (b) Types of thermodynamic processes. Reversibility & Irreversibility Isothermal reversible expansion of an ideal gas. Adiabatic process for an ideal gas Spontaneous and non spontaneous process.
- (c) Second Law of thermodynamic. The Carnot's cycle. Efficiency of an engine. Thermodynamics temperature scale.
- (d) Entropy and its calculations for phase transition. Spontaneity and reversibility. Entropy change in Reversible & irreversible processes. Entropy for an ideal gas. Temperature dependence of entropy. Entropy and probability.
- (e) Concept of free energy. Derivation of Helmholtz and Gibbs Free energy equations. Standard free energy and its relationship with equilibrium constant. Dependence of free energy on pressure and temp. Clausius-Clapeyron equation.

4. SOLUTIONS: (5 Hours)

- (a) Introduction to concentration units of solutions such as molarity, molality, ppm and PPM
- (b) Thermodynamic derivation of colligative properties, lowering of Vapour pressure. Elevation of boiling point. Depression of freezing point. Osmotic pressure and its determination.
- (c) Distillation and concept of azeotropic mixture.

B.Sc. Inorganic Chemistry (Written)

Paper IV

Max. Marks : 37 Time of Exam: 3 Hours

Total Study Hours : 60

Section-I Study Hours : 30

I. PERIODIC CLASSIFICATION OF ELEMENTS AND PERIODIC TABLE:

(a) Modern Periodic Table. Periodic properties i.e, atomic radii, ionic radii, ionization potentials, electron affinities and electronegativities. Redox potential (elementary treatment) Electrochemical series and its applications.

2. CHEMICAL BONDING:

Nature and types chemical bond (Ionic, covalent & coordinate) ionic crystal structure of compounds of the type 1:1 and 1:2. Theories of chemical bonding, quantum mechanical treatment, Valence Bond Theory, Molecular Orbital Theory, (diatomic and heteroatomic molecules) Interpretation of shapes of inorganic molecules on the basis of valence shell electron pair repulsion theory (upto seven electron pairs, lone pairs and molecules containing double and triple bond), hybridization involving s.p.d. orbitals.

Brief description of Electron gas, valence bond and band theories.

3. ACID-BASE EQUILIBRIUM

Theories of Acids, Base and bases including soft and hard acid base concept. Relative strength of acids. Significance of pK . Applications of soft and hard acids and bases. Indicators (acid-base, redox). Solubility, solubility product, common ion effect and its application, Co-precipitation, Hydrolysis of salt, selective precipitation, Fractional and co precipitation

4. ZERO GROUP ELEMENT:

Discovery of Inert gases, separation and isolation, chemistry of Xenon Fluorides, reactivity, bonding and structure of Xenon compounds, commercial utilization of Inert gases.

Section-II Study Hours = 30

1. CHEMISTRY OF P-BLOCK ELEMENTS

(a) Boron & Aluminum:

Gradation of the characteristic properties within the group. Electron deficient molecules such as boron hydrides and aluminum hydrides including their structure. Compounds of boron and aluminum, boric acid, borax and alums, their preparation, properties, uses.

(b) Carbon and Silicon:

Gradation of the characteristic properties within the group. Comparison of C Si. Carbides, different types, silicates and their structures.

(c) Nitrogen & Phosphorus:

Gradation of the characteristic properties within the group. Oxide of nitrogen, hydrazine, hydroxyl amine, phosphine. Ortho, Pyro and Meta phosphoric acid (Preparation and reactions)

(d) Oxygen and Sulphur:

Gradation of the characteristic properties within the group. Role of Sulphur Dioxide in Pollution of air. Thionic acids, Sodium thiosulphate preparation, properties, structure, peroxy acids of sulphur preparation and reaction. Use of Hypo in photography.

(e) Halogens:

Gradation of the characteristic properties within the group. Anomalous behaviour of fluorine, industrial preparation of Fluorine. Oxyacids of Halogens. interhalogens preparation properties and structural aspects. Pseudohalogens.

2. Transition Elements:

Electronic configuration of Transition elements. General characteristic of d-block elements. Werner's theory of co-ordination compounds, nomenclature, Nature of coordinate bond. Application of valence bond, molecular orbital and crystal field theories to explain the structure of coordinate compounds, colour and magnetic behavior of coordination compounds. Introduction of chelates, Isomerism — in coordination compounds.

Recommended Books:

1. Iqbal., M.Z. Text Book of Inorganic Chemistry, Ilmi Kitab Khana, Revised Edition (1998)
2. Chaudhry, G.R.; Text Book of Inorganic Chemistry, New Kitab Markaz, Aminpur Bazar, Faisalabad, Pakistan 2nd Edition 2001.
Bhatti, H.N., and B.A. Nasir, Modern Inorganic Chemistry, The Carvan Book House, Lahore Pakistan 1st Edition 2000.
Cotton, F. Albert, Geoffrey Wilkinson and Paul L. Gaus, Basic Inorganic Chemistry, John Wiley & Sons, Inc., 3rd Edition i 995.
5. Lee, L.D. Concise Inorganic Chemistry, Chapman & Hall, Edition (1996)
6. Jolly, William. L., Modern Inorganic Chemistry, `T'vicGraw Hill, 2' Edition

(1991)

7. Philip M., Advance Analytical Chemistry, Mcgraw Hill International Edition, 2000.

Recommended Books:

1. Marson S.H. & B Jerome, Fundamentals of Physical Chemistry, Macruthan Publishing Co., Inc New York (Also published by national Book Foundation)
2. Atkins P.W. & M. J Clugston, "Principles of Physical Chemistry" Pitman Publishing Company (1998)
3. Moore W.J., "Physical Chemistry" 5th Edition Longman Publishers.
4. Akhtar M.N. & Ghulam Nabi, Principles of Physical Chemistry" Carwan Book House, Lahore.

Paper VI Practicals B.Sc Part II

Time of Exam: 4 Hours

Marks **0**

Study Hours : 45

Practical layout

Total Marks: 20

Q.No.1	Inorganic Chemistry Practical=	10
Q.No.2	Physical Chemistry Practical =	10
Q.No.3	Viva	= 03
Q.No.4	Practical Note Books	02

Note: Relevant books / note books etc. are not allowed in exam for help.

Inorganic Practical Syllabus

1. Qualitative Analysis.
Analysis of four radicals (cations and anions) from salt mixture.
2. Quantitative Analysis
 - a. Determination of total hardness of water using EDTA.
 - b. Estimation of manganese (II) using EDTA.
 - c. Estimation of copper (iodometrically).
 - d. Determination of thiosulphate ion (iodometrically).
 - e. Determination of ferricyanide using K⁺ solution.
 - f. Determination of chloride by Volhard's and Mohr's methods.

- g. Percentage determination of ferric ions in ferric alum using KMnO_4 solution.
- h. Estimation of ferrous ions using $\text{K}_2\text{Cr}_2\text{O}_7$ solution.
- i. Percentage determination of barium in barium nitrate by gravimetric method.

Note: there will be only one question from qualitative / quantitative analysis from inorganic portion.

List of Practicals of Physical Chemistry

1. Determination of Surface tension and Parachor value by stalagmometer.
2. Determination of percent composition of liquid solutions from surface tension measurement.
3. Determination of viscosity and Rhechor value of liquids from viscosity measurement.
4. Determination of percent composition of liquids solutions viscometrically.
- 5- Determination of refractive index and molar refractivity be refractometer.
6. Determination of percent composition of liquid solutions by refractive index measurements.
7. Determination of heat of solution by solubility method.
8. A kinetic study of acid hydrolysis of ethyl acetate.
9. Determination of angle of rotation of an optically active substance.
10. Determination of percent composition of an optically active substance in solution.
11. Determination of equilibrium constant $\text{KI} + \text{I}_2 \rightleftharpoons \text{KI}_3$

Books Recommended:

1. Levitt B.P. Findlays Practical Physical Chemistry, 9th Ed Langan Group Limited.
2. Das R.C. and be Behaera, "Experimental Physical Chemistry" Tata McGraw Hill Publishing Company Limited,
3. Crocleford H.D. HW Biard F.W. Getzen & JW Nowell" Laboratory Manual of Physical Chemistry 2^{ne} Ed. John Wiley & Sons London.

Time of Exam: 4 Hours

Max. Marks : 25

Study Hours : 45

Practical layout

Total marks: 20

Q.No.	1.	Physical Chemistry Practical	=	10
	2 .	Inorganic Chemistry Practical	=	10
	3 .	Viva	=	3
	4 .	Practical Note Books		

NOTE: Relevant books / note books etc are not allowed in exam for help.

Practical Syllabus

I. Qualitative Analysis.

Analysis of four radicals (cations and anions) from salt mixture.

Quantitative Analysis.

- a. Determination of total hardness of water using EDTA.
- b. Estimation of manganese (II) using EDTA.
- c. Estimation of copper (iodometrically).
- d. Determination of thiosulphate ion (iodometrically).
- e. Determination of ferricyanide using $K_4Fe(CN)_6$ solution.
- f. Determination of chloride by Volhard's and Mohr's methods.
- g. Percentage determination of ferric ions in ferric alum using $KAl(SO_4)_2$ solution.
- h. Estimation of ferrous ions using $K_2Cr_2O_7$ solution.
- i. Percentage determination of barium in barium nitrate by gravimetric method.

Note: There will be only one question from qualitative/quantitative analysis from inorganic portion.