

SwamiRamanandTeerthMarathwadaUniversity, Nanded



B.O.S. in Chemistry

B.Sc. Third Year (Chemistry)

Semester V & VI

New Revised Syllabus, In force from -

B.Sc. III Year : Semester – VI
(Organic + Inorganic Chemistry)
Paper - XIV (A+B) (CH-303)

Marks – 50

Periods - 45

Section – A (Organic Chemistry)

Spectroscopic Methods

Unit – I :

07P

i) Introduction, Electromagnetic radiations; Characteristics of EMR :-

- a) Wave length b) Wave number
- c) Frequency d) Energy of EMR

ii) Electromagnetic spectrum; Meaning of Spectroscopy, types of Spectroscopy and advantages of Spectroscopic methods.

(1) U. V. Spectroscopy :

- 1.1.1 Introduction.
- 1.1.2 Absorption of U.V.radiations : Beer-Lambert Law and Molar Absorption.
- 1.1.3 Types of Electronic Transitions.
- 1.1.4 Terms used in U.V.Spectroscopy : Chromophore, Auxochrome, Bathochromic Shift, Hypsochromic Shift, Hypochromic and Hyperchromic effects.
- 1.1.5 Effect of conjugation on position of U.V. and Visible bands.
- 1.1.6 Calculation of λ_{\max} by Woodward – Fieser rules for conjugated dienes and enones.
- 1.1.7 Spectral problems based on U.V.

(2) I.R.Spectroscopy :

- 1.2.1 Introduction
- 1.2.2 Principle of IR Spectroscopy.
- 1.2.3 Fundamental Modes and types of Vibrations. Hooke's Law.
- 1.2.4 Conditions for absorption of IR-radiations.
- 1.2.5 IR Spectrum : Functional group region and Fingerprint region.
- 1.2.6 Characteristic absorption of various functional groups.
- 1.2.7 Interpretation of IR spectra of following organic compounds :
 - a) Ethane b) Ethene c) Ethyne d) Benzene e) 1-propanol f) 2-propanol
 - g) t-butyl alcohol h) Phenol i) Acetone j) Acetophenone k) Acetaldehyde
 - l) Benzaldehyde m) Benzoic acid n) Methylbenzoate o) Phenylcyanide

Unit – II :

NMR – Spectroscopy :

07 P

- 2.1 Introduction
- 2.2 Principle of NMR Spectroscopy
- 2.3 Magnetic and non-magnetic nuclei
- 2.4 PMR-Spectroscopy :- Spinning nuclei, magnetic moment and magnetic field, precessional motion, energy states for proton in magnetic field (Orientations) and nuclear resonance.
- 2.5 Equivalent and non-equivalent protons
- 2.6 Number of absorption signals in the following compounds :
 - a) Acetone b) Cyclobutane c) Methanol d) Ethylbenzene e) Ethylamine
 - f) Mesitylene g) Diethylether
- 2.7 Shielding and deshielding effects : (Example of Acetylene and Benzene)
- 2.8 Chemical shift, measurement of chemical shift by delta scale and tau scale
- 2.9 TMS as reference, Advantages of TMS.
- 2.10 Peak area (integration) & spin-spin Splitting (n+1) rule
- 2.11 Definition of coupling constant : (J-values) of first order coupling
- 2.12 Interpretation of PMR Spectra of following compounds :
 - a) Ethyl bromide b) Ethyl alcohol c) Acetaldehyde
 - d) 1,1,2-tribromo ethane e) Ethyl acetate f) Toluene
 - g) Acetophenone h) Ethylamine i) Acetic acid
 - j) Benzoic acid
- 2.13 Problems pertaining to the structure elucidation of simple organic compounds using PMR-Spectroscopic data (Supporting IR and UV data to be given)
ORGANIC COMPOUNDS :
 - a) n-propylalcohol b) Iso-Propyl alcohol c) ter.butyl alcohol
 - d) Acetic acid e) Ethylamine f) Ethyl cyanide
 - g) Ethyl methyl ketone h) Ethyl acetate i) Ethyl benzene
 - j) Phenyl acetaldehyde k) Phenol l) Ethyl methyl ether
 - m) Ethylene glycol n) Propionamide o) Propionaldehyde

Unit – III :

08P

Amino acids, Peptides and Proteins

(1) Amino Acids :

- 3.1.1 Introduction & classification (acidic, basic and neutral).
- 3.1.2 Dipolar nature of amino acids : Zwitter ion, iso electric point.
- 3.1.3 Methods of Preparation of α -amino acids :
 - a) From α -halo acids
 - b) By Gabriel's Phthalimide Synthesis
 - c) By Strecker's Synthesis
- 3.1.4 Chemical Properties of α -amino acids :
 - a) Reactions due to $-\text{NH}_2$ group
 - b) Reactions due to $-\text{COOH}$ group
 - c) Reactions due to both $-\text{NH}_2$ and $-\text{COOH}$ groups
- 3.1.5 Reagents used for identification of amino acids

(2) Peptides :

- 3.2.1 Introduction, classification and nomenclature
- 3.2.2 N-terminus and c-terminus protecting agents
- 3.2.3 Synthesis of peptides from amino acids : (di- & tri-)
 - a) By protecting $-\text{NH}_2$ group (Using carbobenzoxy chloride)
 - b) By protecting $-\text{COOH}$ group (Using benzyl alcohol)
- 3.2.4 Use of DCC (Dicyclohexyl Carbodiimide) as reagent for peptide bond \ formation

(3) Proteins :

- 3.3.1 Introduction, Tests for proteins.
- 3.3.2 Classification : on the basis of structure and hydrolysis products.
- 3.3.3 General characteristics of proteins.
- 3.3.4 Importance of proteins

Unit – IV :

08 P

Synthetic Polymers and Molecular Rearrangements

(1) Synthetic Polymers :

- 4.1.1 Introduction, Homopolymers and Copolymers.

- 4.1.2 Classification of Polymers : On the basis of source, structure, nature of preparation and molecular forces.
- 4.1.3 Types of Polymerisation reactions :
- a) Addition (Chain-Growth) Polymerisation reaction : (with mechanism)
 - i) Free radical, ii) Cationic & iii) anionic
 - b) Condensation (Step-Growth) Polymerisation reaction
Example : Bakelite (Phenol-formaldehyde resin)
- 4.1.4 Synthesis and uses of following polymers :
- a) Nylon – 6, 10 b) Polyurethanes
 - c) Neoprene d) Polymethylmethacrylate
 - e) Glyptal f) Thiokol

(2) Molecular Rearrangements :

- 4.2.1 Introduction, types of rearrangements
- 4.2.2 Study of following rearrangements with mechanism
- a) Pinacole – Pinacolone
 - b) Fries
 - c) Baeyer – Villiger
 - d) Wolff
 - e) Hofmann

Section – B (Inorganic Chemistry)

Unit-V

Coordination theory (Part-II)

10 P

- 5.1.1)** Valence bond theory of coordination compounds: Postulates, inner orbital and outer orbital complexes of coordination number 4 and 6. Limitations of VBT.
- 5.1.2)** Crystal field theory: Shape of d-orbital's, postulates, splitting of d-orbital in octahedral complexes, tetrahedral complexes, tetragonal and square planar complex. Definition of CFSE, calculations of CFSE for octahedral and tetrahedral complexes.
- 5.1.3)** Factors affecting $10 Dq$ or magnitude of crystal field splitting : Nature of ligand, oxidation state of metal ion, size of d orbital, geometry of complexes.
- 5.1.4)** Applications of CFT.
- 5.1.5)** Jahn teller effect in octahedral complexes of Cu^{++} .
- 5.1.6)** Limitations of CFT.

Electronic spectra of Transition metal complexes:

05 P

- 5.2.1) Types of electronic transition]
- 5.2.2) Selection rule for d-d transition
- 5.2.3) Spectroscopic ground state and spectrochemical series
- 5.2.4) Orgel energy level diagram for d^1 and d^9 states
- 5.2.5) Discussion of electronic spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ complex ion

Reference Books :

- 1) Organic chemistry by S.M.Mukherji, S.P.Singh, R.P.Kapoor (Vol. II & III)
- 2) Organic Chemistry by Jagdamba Singh, L.D.S.Yadav (Vol. II & III)
- 3) A text book of organic chemistry by P.L.Soni, H.M.Chawla
- 4) A text book of organic chemistry by K.S.Tewari, S.N.Mehrotra, N.K.Vishnoi
- 5) A text book of organic chemistry by Arun Bahl and B.S.Bahl
- 6) Principles of organic chemistry by M.K.Jain
- 7) Heterocyclic chemistry synthesis, reactions and mechanism by Raj K. Bansal
- 8) Reaction mechanism and reagents in organic chemistry by G.R.Chatwal
- 9) Synthetic organic chemistry by G.R.Chatwal
- 10) Natural products by O.P.Agarwal (Vol. I & II)
- 11) Spectroscopy of organic compounds by P.S.Kalsi
- 12) Elementary organic absorption spectroscopy by Y.R.Sharma
- 13) Absorption spectroscopy of organic molecules by V.M.Parikh
- 14) Chemistry of pesticides by K.H.Buchel (T.W.)
- 15) Polymer Science by V.R.Gowarikar, N.V.Viswanathan and Jayadev Sreedhar
- 16) Medical Chemistry by Burger
- 17) Organic Chemistry by Clayden, Greeves, Warren and Wothers
- 18) Reactions, Rearrangements and reagents by S.N.Sanyal
- 19) Synthetic organic chemistry by Kamlesh Bansal
- 20) A text book of synthetic drugs by O.D.Tyagi, M.Yadav
- 21) Synthetic drugs by G.R.Chatwal
- 22) Synthetic dyes by G.R.Chatwal
- 23) Industrial Chemistry by B.K.Sharma
- 24) Organic Chemistry by Morrison and Boyd
- 25) Organic Chemistry by Carey

- 26) Organic Chemistry by L.G.Wade
- 27) Organic Chemistry by Cram D.J. and Hammond G.S.
- 28) Organic Chemistry by I.L.Finar
- 29) Advanced Organic Chemistry by Jerry March
- 30) Organic Chemistry by Fieser and Fieser
- 31) Principles of Inorganic Chemistry by Puri, Sharma and Kalia.
- 32) Inorganic Chemistry by Gurudeep Raj, Chatwal.
- 33) Advanced Inorganic Chemistry Vol. II by Satyaprakash, Tuli, Basu and Madan.
- 34) Inorganic Chemistry by huheey, Keiter and Keiter.
- 35) Concise Inorganic Chemistry by J.D. Lee.

**B. Sc. Third Year, Semester-VI
Paper-XV (CH-304)**

Marks: 50

Periods 45

Section-A Physical chemistry

Unit-I

Electrochemistry

12P

- 1.01 Introduction to electrochemistry, concept of electrode potential, single electrode potential and standard electrode potential, oxidation and reduction potential.
- 1.02 Electrochemical cells: Electrolytic and Galvanic cells-reversible and irreversible cells, conventional representation of electrochemical cells.
- 1.03 EMF of cell, measurement of EMF.
- 1.04 Reference electrodes, indicator electrodes, calomel electrode.
- 1.05 Relation between EMF and ΔG , ΔH and ΔS .
- 1.06 Nernst equation, application of Nernst equation to oxidation half cell and reduction half cell.
- 1.07 Electrolyte concentration cell: Concentration cell with transport and Concentration cell without transport.
- 1.08 Application of EMF measurement in determination of pH by using a) Quinhydrone electrode and b) glass electrode.
- 1.09 Potentiometric titrations.
- 1.10 Numerical on Nernst equation, concentration cell, ΔG , ΔH and ΔS .

Unit-II:

Thermodynamics I :

07 P

- 2.1 Introduction
- 2.1 Work Function and Free Energy Function: Helmholtz function (A) or work function, change of A at constant temperature, Gibb's free energy (G) or free energy function, relation between G and A, change of G at constant temperature, variation of work function with temperature and volume, variation of free energy function with temperature and pressure. The Gibb's-Helmholtz equation.
- 2.3 The Nernst heat theorem. Third law of thermodynamics.
- 2.4 Thermodynamics of open system: partial molar properties; concept of chemical potential, partial molar free energy. Gibb's-Duhem equation. Variation of chemical potential with temperature and pressure. Chemical potential in case of a system of ideal gases.

Unit – III :

Thermodynamics II :

05 P

- 3.1 Vant-Hoff's isotherm. Vant-Hoff's reaction isochore. Integrated form of Vant-Hoff's equation.
- 3.2 Clausius- Clapeyron equation and its applications.
- 3.3 Thermodynamic derivation of law of mass action. Relation between ΔG° and K_p .
- 3.4 Numericals on Vant-Hoff's isotherm and Integrated form of Vant-Hoff's equation.

Unit-IV

Magneto chemistry and magnetic properties of substance

06P

- 4.1 Introduction, Magnetic susceptibility, Specific susceptibility, unit of measurement
- 4.2 Types of substances: Paramagnetic, diamagnetic and ferromagnetic.
- 4.3 Effect of temperature on Paramagnetic, diamagnetic, ferromagnetic substances.
- 4.4 Measurement of magnetic susceptibility: Gouy's method.

Section – B (Inorganic Chemistry)

Unit V

1) Bioinorganic Chemistry

05P

- 5.1.1) Essential and trace elements in biological processes
- 5.1.2) Metalloporphyrin with special reference to hemoglobin and myoglobin
- 5.1.3) Biological role of alkali and alkaline earth metal ions
- 5.1.4) Nitrogen fixation

2) Metal cluster

10P

- 5.2.1) Boranes
- 5.2.2) Carboranes
- 5.2.3) Metalloboranes
- 5.2.4) Metallocarboranes

Reference Books:

1. Physical Chemistry by G. M. Barrow (Tata Mc-Graw Hill publishing Co., Ltd.)
2. Elements of Physical Chemistry by S. Glasstone & D. Lewis (D.van nostrand co. inc.)
3. Physical Chemistry by W. J. Moore (Orient Longman).
4. Principles of Physical Chemistry by S. H. Maron and C. F. Prutton.
5. University General Chemistry by C. N. R. Rao (Mc-Millan).
6. Elements of Physical Chemistry by P. W. Atkins. (Oxford University Press).
7. Physical Chemistry by R. A. Alberty (Wiley Eastern Ltd.).
8. Physical Chemistry through problems by S. K. Dogra, D. Dogra(Wiley Eastern Ltd)
9. Principles of Physical Chemistry by Puri, Sharma and Pathania (Vishal Publication Jalandher, Delhi)
10. Physical Chemistry by A. J. Mee. ELBS & Heinemann Educational Books Ltd.
11. Essentials of Physical Chemistry by Arun Bhal, B. S. Bahl and G. D. Tuli. (S. Chand)
12. Kinetics by K. J. Laidler (Tata Mc-Graw Hill Publishing Co. Ltd).
13. Text Book of Physical Chemistry by Soni-Dharmarha.
14. A Text Book Physical Chemistry by S. Glasstone, (Mac Millan.)
15. Advanced Physical Chemistry by D.N.Bajpai. (S.Chand)
16. Advanced Physical Chemistry by Gurdeep Raj. (Goel publishing house, Meerut).
17. Principles of Inorganic Chemistry by Puri, Sharma and Kalia.
18. Inorganic Chemistry by Gurudeep Raj, Chatwal.
19. Advanced Inorganic Chemistry Vol. II by Satyaprakash, Tuli, Basu and Madan.
20. Inorganic Chemistry by huheey, Keiter and Keiter.
21. Concise Inorganic Chemistry by J.D. Lee.

B.Sc. III Year : Semester – (V + VI)

(Organic + Inorganic Chemistry)

Paper - XVI (A+B)

Periods – 120

Laboratory Course – IV (CH-305)

Marks - 50

Note : At least Sixteen experiments to be completed :

(Twelve from Section A and four from Section B)

Section – A (Organic Chemistry)

01. Organic qualitative analysis : (Seven mixtures)

Separation of organic binary mixture containing two solid components (Using NaHCO_3 , NaOH and HCl) and analysis of (both/one) components with preparation one derivative of each.

At least one mixture from each of the following types should be given:

- | | |
|---------------------|-------------------|
| a) Acid + Phenol | b) Acid + Base |
| c) Acid + Neutral | d) Phenol + Base |
| e) Phenol + Neutral | f) Base + Neutral |

Following compounds should be used for preparation of mixtures :

A] Acids : Salicylic acid, Phenyl acetic acid, o-Chlorobenzoic acid, aspirin, ophthalmic acid cinnamic acid, Benzoic acid, m-cholorobenzoic acid.

B] Phenols : α -naphtha, β -naphtha, Resorcinol, p-nitro phenol, m-nitro phenol, Hydroquinone,

C] Bases : o-nitroaniline, m-nitroaniline, p-nitroaniline, p-anisidine, diphenylamine, p-Toluidine, p-chloroaniline

D] Neutrals : Acetanilide, Anthracene, Benzamide, Benzophenone, Biphenyl, Naphthalene, m-Dinitrobenzene, p-Dichloro benzene

02. Organic Preparation : (Any five)

[Weight of crude product, crude % yield, recrystallisation of crude product and its melting point expected]

a) Acetylation : Preparation of Aspirin from salicylic acid

OR

Preparation of β -naphthyl acetate from β -naphthol

b) Electrophilic substitution :

Preparation of p-nitroacetanilide from acetanilide (Nitration)

Preparation of 2, 4, 6 – Tribromoaniline from aniline (Bromination)

OR

Preparation of p-bromo acetanilide from acetanilide (Bromination)

c) Diazotisation : Preparation of Methylorange from sulphanilic acid (Coupling)

OR

Preparation of p-iodonitrobenzene from p-nitroaniline (Replacement)

d) Benzoylation : Preparation of β -naphthyl benzoate from β -naphthol

OR

Preparation of Benzanilide from aniline

e) Osazone formation : Preparation of Glucosazone from Glucose

f) Amide Formation : Preparation of Benzamide from benzoic acid

g) Hydrolysis : Preparation of p-nitroaniline from p-nitroacetanilide

h) Reduction : Preparation of m-nitroaniline from m-Dinitrobenzene

i) Oxidation : Preparation of Benzoic acid from Toluene

j) Polymerisation : Preparation of phenol formaldehyde resin

03. Only demonstrations :

- a) Extraction of clove oil from crushed cloves by steam distillation.
- b) Separation of a mixture of methyl orange and methylene blue by column chromatography
- c) Separation of a mixture of amino acids by ascending paper chromatography.
- d) Separation of various pigments in the extract of spinach leaves by TLC.

Section – B (Inorganic Chemistry)

1. Gravimetric estimation of Iron as Fe_2O_3 .
2. Gravimetric estimation of Ba as BaSO_4
3. Gravimetric estimation of Nickel as $\text{Ni}(\text{DMG})_2$.
4. Gravimetric estimation of Aluminium as $\text{Al}(\text{Oxinate})_3$.
5. Gravimetric estimation of zinc as ZnO
6. Gravimetric estimation of Chloride as AgCl

Reference Books :

- 1) Practical organic chemistry by A.I.Vogel
- 2) Advanced practical organic chemistry by O.P.Agarwal
- 3) Advanced practical organic chemistry by N.K.Vishnoi
- 4) Hand book of organic qualitative analysis by H.T.Clarke
- 5) Experimental practical organic chemistry by P.R.Singh, D.S.Gupta
- 6) A laboratory Hand book of organic qualitative analysis by V.S.Kulkarni
- 7) Hand book of organic qualitative analysis by F.G.Mann, B.C.Sunders
- 8) A text book of Practical Chemistry for B.Sc. by V.V. Nadkarni, A.N. Kothare and Y.V. Lawande.
- 9) Advanced practical Inorganic Chemistry by O.P. Agarwal.

B.Sc. III Year : Semester – (V + VI)
(Physical + Inorganic Chemistry)
Paper - XVII (A+B)

Periods – 120

Laboratory Course – IV (CH-306)

Marks - 50

Note: At least Sixteen experiments to be completed :

(Twelve from Section A and four from Section B)

Section – A (Physical Chemistry)

Instrumental

1. Determine the normality and strength of oxalic acid conductometrically using standard solution of strong base (NaOH/KOH).
2. Determine the concentration of KCl solution by titrating it with standard solution of AgNO₃ conductometrically.
3. Determine the equivalent conductance of a strong electrolyte at several concentration and hence verify the Onsager's equation.
4. Determine the normality and strength of acids in mixture [strong acid(HCl/HNO₃) and weak acid (CH₃COOH/HCOOH)] potentiometrically using standard solution of strong base(NaOH/KOH).
5. Determine the dissociation constant of a weak acid (CH₃COOH/HCOOH) potentiometrically using standard solution of strong base (NaOH/KOH).
6. Determination of empirical formula of a complex between Fe⁺³ and 5-sulphosalicylic acid by Job's method colorimetrically.
7. Determination of dissociation constant of an organic acid (CH₃COOH) using various buffers (CH₃COOH + CH₃COONa) pH metrically.
8. To study inversion of cane sugar by polarimetrically.

Non-Instrumental

1. Determine the rate constant of the reaction between potassium persulphate and potassium iodide having equal concentrations of reacting species (a=b).
2. Determine energy of activation of hydrolysis of an ester by acid/base.
3. Investigate the reaction between bromic acid and hydroiodic acid.
4. Determine molecular weight of non volatile solute by Rast method / Beckmann's freezing point method.
5. Determine enthalpy change of neutralization of a strong acid by a strong base.
6. Determine interfacial tension between immiscible liquids, benzene and water by stalagmometer.
7. Determine molecular weight of a polymer by viscosity measurement.
8. Separation of mixture of o- and p-nitro anilines on an alumina column.

Section – B (Inorganic Chemistry)

1. Inorganic preparations and estimation of metal ion.
 - a) [Cu(NH₃)₄]SO₄
 - b) [Ni(NH₃)₆]Cl₂
 - c) CoCl₃.4NH₃
 - d) Sodium trioxalato ferrate
 - e) Hg[Co(SCN)₄].
 - f) Mohr's salt, [FeSO₄(NH₄)₂SO₄].6H₂O

Reference Books :

1. Experimental Physical Chemistry by A. Findlay., Longman.
2. Advanced Practical Physical Chemistry by J.B. Yadav.
3. Experiments in Physical Chemistry by R.C. Das and B. Behra, Tata Mc Graw Hill.
4. Advanced experimental Chemistry Vol. I. Physical by J.N. Gurtu and R. Kapoor., S. Chand & Co.
5. Experiments in Physical Chemistry by J.C. Ghosh, Bharati Bhavan.
6. Practical book of Physical Chemistry by Nadkarni, Kothari & Lawande., Bombay Popular Prakashan.
7. Systematic Experimental Physical Chemistry by S.W. Rajbhoj, Chondhekar, Anjali Prakashan.
8. Practical Physical Chemistry by B.D. Khosla & V.C. Garg., R. Chand & Sons.
9. Experiments in Chemistry by D.V. Jagirdar.
10. Practical Chemistry, Physical – Inorganic – Organic and Viva – voce by Balwant Rai Satia., Allied Publishers Pvt. Ltd.
11. College Practical Chemistry by H.N. Patel, S.R. Jakali, H.P. Subhedar, Miss. S.P. Turakhia, Himalaya Publishing House, Mumbai.
12. College Practical Chemistry by Patel, Jakali, Mohandas, Israney, Turakhia, Himalaya Publishing House, Mumbai.
13. A text book of Practical Chemistry for B.Sc. by V.V. Nadkarni, A.N. Kothare and Y.V. Lawande.
14. Advanced practical Inorganic Chemistry by O.P. Agarwal