

North Maharashtra University, Jalgaon

M.Sc. Part-I (Semester I and II)

Revised syllabus in Chemistry from July 1997

COURSE STRUCTURE

- 1) Each theory course should be covered in 5 periods, each of 60 minutes, per week, 4 periods for lectures and one for tutorials, seminars etc.
- 2) Each practical course will require 6 hours of laboratory work per week and the course will be extended over two semesters and will be examined at the end of the Year.
- 3) There should not be more than 10 students in a batch of M.Sc. practical course.
- 4) The students taking Physical Chemistry for M.Sc. Part-II must opt section III (Chemical mathematics) of general chemistry course, Ch-290.
- 5) The distribution of course for two semesters will be as under:

Semester I

CH-110 : Physical Chemistry - I
CH-130 : Inorganic Chemistry - I
CH-150 : Organic Chemistry - I
CH-127 : Inorganic Chemistry Practical
CH-147 : Organic Chemistry Practical

Semester II

CH-210 : Physical Chemistry-II
CH-230 : Inorganic Chemistry-II
CH-250 : Organic Chemistry -II
CH-290 : General Chemistry (Any two of the following section)

Section I : Analytical Chemistry
Section II : Instrumental Methods of Analysis

Section III : Chemical Mathematics.
Ch-207 : Physical Chemistry Practical

Physical Chemistry - I CH-10
SECTION - I

- 1) THERMODYNAMICS :
Clausius inequality and its consequences, Helmholtz and Gibbs functions, Relations of Helmholtz function to maximum work and Gibbs function to maximum non-p, V work, Concept of chemical potential of a perfect gas, Partial molar quantities, Partial molar volume, Partial molar Gibbs function, Gibbs-Duhem equation, Method of intercepts to measure partial molar volume, The chemical potentials of liquids, Raoult's and Henry's laws, Liquid mixtures, Excess functions

Ref. 1, Pages : 99 to 100, 101 to 103, 108 to 112, 127, 160

(6)

- 2) **COLLIGATIVE PROPERTIES :**
The common feature, The elevation of boiling point, The depression of freezing point, Volubility, Osmosis and Osmotic pressure.
(All collective properties are to be discussed using the concept of chemical potential only)

Ref. 1, Page : 170 to 176.

(4)

- 3) **STATISTICAL THERMODYNAMICS :**
Thermodynamic probability of a system, Stirling's formula, Boltzman distribution law, The partition function, The energy of a system in terms of partition function, Separation of partition functions, Entropy and probability, Entropy in terms of partition function, Translational, Rotational and vibrational partition functions, Translational energy, heat capacity and entropy, Sackur-Tetrode equation, Rotational energy, heat capacity and entropy, Vibrational energy, heat capacity and entropy.

Ref. 1,2,3,4 & 5; Relevant pages :

- 4) **PHASE RULE :**
Statement of phase rule and explanation of terms involved in it, One component system : Sulphur system, Two component systems ; Liquid-solid Phase diagrams, phase diagrams for reactive systems, Three component systems: Triangular phase diagrams, Water/Chloroform/ acetic acid system, Ammonium chloride/Ammonium sulphate/water system, The role of added salts.

Ref. 1, Pages : 192 to 195, 200 to 207

Ref. 2, Pages : Relevant pages.

(6)

SECTION II

- 5) **THE RATES OF CHEMICAL REACTIONS :**
Accounting for the rate laws, The temperature dependence of reaction rates, Reactions approaching equilibrium, Consecutive reactions, The steady state approximation, Pre-equilibria, Unimolecular reactions.

Ref. 1, Pages : 698 to 709.

(6)

- 6) **THE KINETICS OF COMPLEX REACTIONS :**
Chain reactions, The structure of chain reactions, Branching chains, Polymerization, Explosions and explosion limits, Fast reactions, Flash photolysis, Flow techniques, Relaxation methods.

Ref. 1, Pages : 713 to 721, 729 to 732

Ref. 6, Pages : 24 to 28, 39 to 47, 325 to 329, 415 to 419.

(6)

- 7) **MOLECULAR REACTION DYNAMICS :**
Collision Theory, The basic calculation and steric requirement, Diffusion controlled reactions, Diffusion and reaction, Activated complex theory, The reaction co-ordinate and decay of activated complex, How to use Eyring equation, Thermodynamic aspects, Reactions between ions, Influence of solvent and pressure on rates in solution, Single phase activated complex, Linear free energy relationships, Hammett equation, Taff equation.

Ref. 1, Pages : 737 to 743, 745 to 752
Ref. 6, Pages : 210 to 214, 217 to 222, 231 to 234, 246 to 251.

REFERENCES :

1. Physical Chemistry, ELBS, 3rd edition, By P.W. Atkins
2. Principles of Physical Chemistry, 4th edition, By S.H. Maron and C.F. Prutton
3. Physical Chemistry, Orient Longmans, 4th edition, By W.J. Moore
4. Thermodynamics for Chemists, D. Van Nostrand Co. Inc., By S. Glasstone
5. Theoretical Chemistry, Affiliated East-West Press Pvt. Ltd. New Delhi., By S. Glasstone
6. Chemical Kinetics, TMH, 2nd edition, By K. J. Laidler.

PHYSICAL CHEMISTRY - II CH-20
SECTION - I

1) INTRODUCTION :

Characterization of electromagnetic radiation, Quantization of energy, Regions of the spectrum, The intensity of spectral lines.

Ref. 1, Chapter 1, Pages : 1 to 9, 18 to 19

(2)

2) MICROWAVE SPECTROSCOPY :

The rotation of molecules, Rotational spectra, Diatomic molecules: The rigid diatomic molecules, Intensities of spectral lines, Effect of isotopic substitution, Non-rigid rotator, Spectrum of non-rigid rotator, Polyatomic molecules : Linear molecules, Symmetric top molecules.

Ref. 1, Chapter 2, Pages : 31 to 50.

(5)

3) INFRA-RED SPECTROSCOPY :

Vibrating diatomic molecule, Simple harmonic oscillator, anharmonic oscillator, Diatomic vibrating rotator, Vibration rotation spectrum of CO₂, Breakdown of Born-oppenheimer approximation, Vibrations of polyatomic molecules, Fundamental vibrations and their symmetry, Overtone and combination frequencies, The influence of rotation on spectra of polyatomic linear and symmetric top molecules, Influence of nuclear spin.

Ref. 1, Chapter 3, Pages : 55 to 82.

(6)

4) RAMAN SPECTROSCOPY :

Quantum and classical theories of Raman effect, Pure rotational Raman spectra : Linear molecules, Symmetric top molecules, Spherical top molecules, Vibrational Raman spectra : Raman activity of vibrations, Rule of mutual exclusion, Vibrational Raman spectra, Rotational fine structure, Structure determination from Raman and infrared spectroscopy.

Ref. 1, Chapter 4, Pages : 100 to 116, 119 to 121.

(5)

5) ELECTRONIC SPECTROSCOPY OF MOLECULES :

Electronic spectra of diatomic molecules : Born-oppenheimer approximation, Vibrational coarse structure, Intensity of vibrational-electronic spectra, Frank-Condon principle, Dissociation energy and dissociation products, Rotational fine structure of electronic-vibration transitions, The Fortrat

diagram, Predissociation.

Ref.1, Chapter 6, Pages : 162 to 175.

(6)

SECTION - II

1) RADIOACTIVITY :

Parent-daughter decay-growth relationships : The daughter nucleus stable, General expression for the activity of daughter nuclide, Parent shorter lived than daughter, Parent and daughter of nearly the same half life, Parent longer lived than daughter, Secular and transient equilibrium, Branching decay, Alpha decay : Alpha active nuclides, Range, Ionizing power and energy spectrum of alpha particles, Geiger-Nuttall's law, Theory of alpha decay, Beta decay : Three types of beta decays, Absorption and range of beta particles, types of beta decay, Problems of beta decay, Nuclear excitation, Gamma transition, Isometric transition, Internal conversion, Effects of vacancy filling : Radiation emission and electron emission. (10)

Ref. 2, Pages : 126 to 158, 167, 174 to 179.

2) APPLICATIONS OF RADIOACTIVITY :

Probing by isotopes, Typical reactions involved in the preparation of radioisotopes, The Szilard-Chalmer's reaction, Radiochemical principles in the use of tracers, Applications in Physico-Chemical research : Volubility of sparingly soluble substance and surface area of powder or precipitate, Analytical applications : Isotope dilution analysis, Neutron activation analysis, Neutron absorptiometry, Radiometric titrations.

Ref.2, Pages : 358 to 359, 363 to 368, 371 to 373, 381 to 383, 391 to 401.

(8)

3) ELEMENTS OF RADIATION CHEMISTRY :

Radiation chemistry, Interaction of radiation with matter : Primary effects, LET, Bremsstrahlung, Interaction of gamma radiation with matter : Photoelectric effect, Compton scattering, Pair production, Units of measuring radiation absorption, Absorption in water, Radiation dosimetry : Units of radiation energy, Chemical dosimetry, Conversion of measured dose values, Radiolysis of water : Ionic and free radical products, Hydrated electron, Molecular products, Chain reactions, Distribution of prp of water.

Ref.2, Pages : 427 to 457

(6)

REFERENCES :

1. Fundamentals of molecular spectroscopy
Tata Mc.Graw-Hill Publishing Co. Ltd., 4th edition, By
C.N.Banwell and E.M.McCash
2. Essentials of Nuclear Chemistry
New Age International publishers Ltd., Wiley-Eastern Ltd.,
4th edition, By H.J.Arnikaar.

INORGANIC CHEMISTRY-I, CH-130
SECTION-I

1. Wave Mechanics : Matter waves, Uncertainty principle, wave nature of electron, interpretation of wave function, normalized and orthogonal wave functions, wave equation and principle of superposition.
Ref.1, Pages 26 to 38, Ref. 3, Pages 42 to 45 (4)
2. The particle in one dimensional box, the particle in three dimensional box, degeneracy.
Ref.1, Pages 38 to 45,
Ref.3, Pages 46 52 (3)
3. The hydrogen atom : Transformation of co-ordinates, separation of variables, the phi equation, the theta equation, the radial equation, spherical harmonics. (Mathematical solutions of equations are not expected).
Ref.1, Pages : 45 to 53,
Ref.3, Pages 52 to 53 (3)
4. Quantum states, electron spin, energy states of the hydrogen atom, the self consistent method, wave functions of the hydrogen atom, radial distribution curves, angular dependence of the wave function.
Ref.1, Pages : 54 to 64, Ref.3, Pages : 54 to 59 (4)
5. Molecular orbital theory of polyatomic molecules like, BeH_2 , CO_2 ,
 NH_3 , CH_4 , BF_3 .
Ref.2, Pages : 95 to 147. (6)
6. (A) Valence bond theory : diatomic molecules, polyatomic molecules
(B) Multiple bonding in polyatomic molecules, multicentre bonding, macromolecules and metals.
Ref.3, Pages : 100 to 113 (4)

SECTION-II

1. The structure and energetics of inorganic solids : Introduction, close packing of spheres, structure of ionic solids, ionic radii, radius ratio rules, Born Haber cycle, applications of lattice energies, metals.
Ref.3, Pages : 135 to 162,
Ref.4, Pages : 52 to 71 (8)

2. Inorganic chemistry in aqueous media, hydrogen bonding in water, conventions and units in aqueous solution chemistry, hydration of ions and the solubilities of salts, the ionisation of acids in aqueous solution, complex formation, formation constant of complexes, factors affecting the stabilities of complexes containing only monodentate ligands, redox processes, the stabilisation of oxidation by complex formation of precipitation, potential stated diagrams, and factors oxidation state diagram affecting the magnitude of standard redox potentials.

Ref.4, Pages : 103 to 136

Ref.3, Pages : 167 to 195

(10)

3. Some physical properties of molecules, the shapes of molecules and ions of non-transition elements, symmetry, bond energies, force constants, bond lengths, bond polarities and electronegativity.

Ref.3, Pages : 115 to 133,

Ref.4, Pages : 90 to 101.

(6)

INORGANIC CHEMISTRY-II, CH-230 SECTION-I

1. Features of solids : Band theory of solids, defects inherent in the thermodynamics of the solid state, specific defect structures, stoichiometric defects, non-stoichiometric defects, semiconductors and transistors, rectifiers, photovoltaic cells, microminaturized semiconductor devices, integrated circuits.

Ref. 5, Pages 58 to 68,

Ref. 4 pages 73 to 89

(8)

2. Vector model of atom and spectroscopic terms, energy levels in an atom, coupling of orbital angular momenta, spin-orbit coupling, determination of ground state terms for closed sub-shell, derivation of terms for P^2 and d^2 configuration, hole formulation, calculation of number of microstates.

Ref.2, Pages : 22 to 27,

Ref.5, Pages : 938 to 950.

(4)

3. Physical methods of inorganic chemistry : General principles, merits, demerits and applications of X-ray diffraction, neutron diffraction and electron diffraction (numerical problems are not expected).

Ref.4, Pages : 23 to 30.

(4)

4. Reactions in non-aqueous solvents : Anhydrous sulphuric acid, other protonic solvents, aprotic solvent systems, the halogens, interhalogen compounds, other covalent hydrides, oxy-halides, dinitrogen tetroxide, sulphur dioxide.

Ref.4, Pages : 150 to 168.

(8)

SECTION-II

1. Thermodynamic aspects of transition metal chemistry :
Crystal field stabilization energies of the octahedral and tetrahedral complexes, oxidation states in aqueous media, ionization energies.

Ref.3, Pages : 490 to 502,

Ref.4, Pages : 505 to 529

(8)

2. d-block transition elements :
General properties, scandium group, titanium group, vanadium group, chromium group, manganese group, iron, cobalt and nickel group, horizontal comparison in the iron, cobalt, nickel group, copper group, zinc group.

Ref.6, Pages : 294 to 393.

(16)

REFERENCES :

1. Theoretical inorganic chemistry (Second edition), By Day and Selbin., Affiliated east-west press Pvt. Ltd., New Delhi.
2. Electrons and Chemical Bonding (1964), By H.B. Gray, W.A. Benjamin, New York.
3. Inorganic Chemistry, By A.G. Sharpe, ELBS and Longman group Ltd.
4. Modern Aspects of Inorganic Chemistry, By H.J. Emeleus and A.G. Sharpe, Universal book stall, New Delhi-2
5. Concise Inorganic Chemistry (Fourth edition), By J.D. Lee, ELBS with Chapman and Hall.
6. A New Concise Inorganic Chemistry (Third edition), By J.D. Lee, ELBS Van Nostrand Reinhold (UK)

ORGANIC CHEMISTRY-I, CH-150

1. Energetics, Kinetics and investigation of mechanism.
Ref.4, Pages : 33 to 52

(6)

2. (A) Nucleophilic substitution at a saturated carbon.
(B) Scope of nucleophilic substitution
 - i) Substitution by sulphur nucleophiles
 - ii) Substitution by nitrogen nucleophiles
 - iii) Substitution by phosphorous nucleophiles
 - iv) Substitution by tertiary amines
 - v) Neighboring group participation
 - vi) Substitution by organometallic reagents.

Ref.1, Pages : 319 to 340, 369 to 389

(15)

3. (A) Electrophilic aromatic substitution
(B) Nucleophilic aromatic substitution, arylne intermediates

Ref.1, Pages : 616 to 631, 648, 651 to 657, 662 to 668.

(9)

4. Elimination reactions,

Ref.1, Pages : 466 to 486, 495 to 497.

(9)

5. Addition reactions

Ref.1, Pages : 517 to 525, 541 to 549, 677 to 687.

(9)

ORGANIC CHEMISTRY-II, CH-250

1. Rearrangements :
Wagner-Meerwein, Pinacol, Wolf, Arndt-Eistert, Hofmann, Curtius,
Schmidt, Lossen, Beckmann, Baeyer-viliger, Favorskii, Benzillic
acid, Stevens, Witting, Claisen.
Ref.1, Pages : 973 to 994, 997 to 1005 (12)
2. Oxidation and reduction :
 Na Cr O_2 , O_2 , Pb(OAC)_4 , KM O_4 , NBS, hydrazine/KOH, H O_2 ,
 SO_2 , Na-liq.NH_3 , NaBH_4 , LiAlH_4 , Catalytic hydrogenation,
 SeO_2 , periodic acid, diborane.
Ref.2, Pages : 538 to 562. (8)
3. Stereochemistry :
Actual shape of six membered rings and its relation to the
properties and reactivity.
Ref.3, Pages : 204 to 234. (8)
4. Spectroscopic methods : UV, IR and NMR.
Ref.1, Pages : 1063 to 1083, 1095 to 1119. (15)
5. Combined problems based on UV, IR and NMR, problems on UV
calculation based on Woodward and Hoffmann rules. (5)

REFERENCES :

1. Organic chemistry by Staley H-pine.
Fifth edition, Mc Graw Hill, International edition.
2. Organic chemistry by Cram and Hammond second edition. Tata McGraw
Hill.
3. Stereo Chemistry of Carbon Compounds by Ernest L. Eliel Tata Mc-
Graw Hill edition. (1975)
4. A Guide Book to Mechanism in Organic Chemistry by Peter Sykes.
Fifth edition, orient - longmann group ltd. (1982).

GENERAL CHEMISTRY CH-290
(ANY TWO SECTIONS)
SECTION-I ANALYTICAL CHEMISTRY

1. Data Handling :
Significant figures, rounding off, accuracy and precision,
determinate errors, indeterminate errors, ways of expressing
accuracy, ways of expressing precision, control charts, the
confidence limit, tests of significance, the rejection of result,
linear least squares, the correlation coefficient.
(The solution of numerical problems is expected.).
Ref.1, Pages : 59 to 82. (12)
2. Chromatographic Methods :
(A) Gas chromatography : Principles, gas chromatography column, gas
chromatography detectors, column efficiency in gas
chromatography, some practical aspects of gas chromatography.
(B) High performance liquid chromatography : Principles, equipment
for HPLC, choice of the column materials for HPLC.

- (C) Electroforesis : Moving boundary electroforesis, zone electroforesis, curtain electroforesis, disc electroforesis.
Ref.1, Pages : 475 to 494, 499 to 501. (9)

3. Pollution Analysis :

- (A) Air Analysis : Air sample collection, air sample analysis.
(B) Water Analysis : Sampling of water, analysis of water samples.

Ref.1, Pages : 583 to 589. (3)

REFERENCES :

1. Analytical Chemistry
By G.D.Christian, John. Wiley and Sons Inc. (Third edition)

SECTION-II INSTRUMENTAL METHODS OF ANALYSIS

1. Polarography :
Basic principles, polarization of electrodes, current voltage relationships, dropping mercury electrodes and its characteristics, direct current polarography, residual, migration, diffusion and kinetic currents, Ilkovic equation, half wave potential and its derivation, maximum supressor, oxygen interference, manual non recording polarograph, ancillary equipment for cells, applications of polarographic analysis in quantitative estimations, chronopotentiometry, amperometric titrations : principle, equipment and technique, applications, rotating platinum electrode, biamperometric titrations.

Ref.1, Chapter 24, Ref.2, Chapter XVI, Ref.3, Chapter 15,
Ref.4, Chapter 23, Ref.5, Chapter 19 (relevant pages)

(10)

2. Atomic Absorption Spectrometry :
Principle, instrumentation : radiation sources, chopper, atomizer, burner, nebulizer, monochromator, detectors, amplifiers, difference between AAS and FES, applications.

Ref.2, Chapter XXII,
Ref.4, Chapter 6,
Ref.5, Chapter 5,
Ref.6, Chapter-9. (Relevant pages)

(5)

3. Mass Spectrometry :
Introduction components of mass spectrometer, inlet sample system, ionization sources, ion collection system, vacuum system, resolution, mass spectrometer, applications : mass determination, isotopic abundance, isotopic dilution method.

Ref.1, Chapter 19,
Ref.3, Chapter 21,
Ref.5, Chapter 14,
Ref.6, Chapter 18 (Relevant Pages)

(6)

4. Radioactivity as Analytical Tool :
Scintillation counter, pulse height analyzer, counting errors.
Ref.7, Chapter, Ref.8, Chapter 9.

(3)

REFERENCES :

1. Instrumental Methods of Analysis
By Willard, Dean, Merrit, Settle (6th edition), CBS Publications,
Delhi.
2. Vogel's text book quantitative analysis, By Vogel, (4th edition)
ELBS Longman.

3. Instrumental Methods of Chemical Analysis, By Ewing, International student, (4th edition)
4. Introduction to Instrumental Analysis, By Brawn, International edition Mc-Graw Hill
5. Instrumental Methods of Chemical Analysis, By B.K.Sharma, Goel publication Meerut
6. Principles of Instrumental Analysis
By Skoog, Saunders college publishing.
7. Essentials of Nuclear Chemistry
By H.J.Arnikaar (4th edition), Wiley Eastern
8. Instrumental Methods of Analysis
By, Willard, Dean, Merrit, Settle (4th edition), CBS publications Delhi.

SECTION-III CHEMICAL MATHEMATICS

1. Differential Calculus :
Derivative and its physical significance, basic rules of differentiation (without derivation), maxima and minima and their applications in chemistry, differentiation of trigonometric functions, partial differentiation.
Ref.1, Chapter : VII, VIII, IX, X, XIII, XVII. (6)
2. Integral Calculus :
Basic rules of integration (without derivation), integration between limits, integration of trigonometric functions, integration by algebraic simplification by substitution, by parts, by partial fractions, geometrical applications of integral calculus.
Ref.1, Chapter : XI, XIII, XIV, XVI. (6)
3. Differential Equations :
Simple differential equations in physical chemistry, separable variables, homogeneous differential equations, exact and inexact differential equations, linear differential equations.
Ref.1, Chapter : XVIII. (4)
4. Errors :
Permutation and combinations, errors.
Ref.1, Chapter XX. (2)
5. Graphical Methods in Physical Chemistry :
Method of averages and least squares.
Ref. 1, Chapter- XXI (2)
6. Problems in Physical Chemistry :
Ref.1, Appendix-I (4)

REFERENCES :

1. Mathematical Preparation of Physical Chemistry
By F.Daniels, Mc-Graw Hill Book Co. Inc.

INORGANIC CHEMISTRY PRACTICALS CH-127

1. Ore analysis : Pyrolusite ore (Mn and Si), Haematite ore (Fe and Silica)
2. Alloy analysis : Solder alloy (Sn and Pb), Brass (Cu and Zn), Steel (Fe and Ni)
3. Synthesis and estimation of
i) Chromium in cis-trans potassium diaquo dioxalate chromates (III)

- ii) Cobalt in chloropentammine cobalt (III) chloride.
 - iii) Aluminum in potassium trioxalate acuminate.
 - iv) nickel in tries ethylene diamine Ni(II) thiosulphate.
4. Determination of phosphorus from the fertilizer.
 5. Estimation of calcium from a drug sample.
 6. Estimation of each of the constituents of binary mixture (Co and Ni⁺⁺).
 7. Simultaneous determination of Cr⁺⁶ and Mn⁺⁷ spectrophotometrically.
 8. Effect of impurity ions addition on the Beer's law system, such as Ni⁺⁺ on Co-R-nitrososalt.
 9. Determination of lattice energy of binary salts by heat of dissolution system such as CaCl₂, NiCl₂, CuCl₂, MnCl₂, CoCl₂.

REFERENCES :

1. Vogel's Text Books of Quantitative Chemical Analysis

ORGANIC CHEMISTRY PRACTICALS CH-147

1. Derivatives of functional groups :

Functional group	Derivative
i) -COOH	Amide, Anilide
ii) -Ar-OH	Anyloxyacetic acid
iii) -NH ₂	Acetyl, benzoyl
iv) -CHO	Oxime, Semicarbazone
v) -R-CO-R	2:4 DNP
2. Single stage preparation (any six) :

i) Anisole	-- 2,4 nitroanisole
ii) Benzophenon	-- Benzhydrol
iii) Anthracene	-- Anthraquinone
iv) P-nitroaniline	-- P-iodonitrobenzene
v) P-toluidine	-- P-chlorotoluene
vi) Acetoacetic ester	-- 1-phenyl 3-methyl 5-pyrazolone
vii) m-dinitrobenzene	-- m-nitroaniline
viii) O-nitrotolunene	-- O-nitroaniline
3. Two stage preparation (Any two) :

i) Aceto phenone	-- Benzal aceto phenone	-- Epoxide
ii) Benzophenone	-- Oxime	-- Benzanilide
iii) Phthalic anhydride	- Phthalimide	- Anthranilic acid
iv) Hydroquinone	-- Quinone	-- 1,2,4 triacetoxy benzene

REFERENCES :

1. Practical Organic Chemistry by A.I.Vogel
2. Laboratory Manual of Organic Chemistry
By Raj K. Bansal, Second edition (1990)

PHYSICAL CHEMISTRY PRACTICALS CH-207

- 1) CONDUCTOMETRY
- 1) Hydrolysis of aniline hydrochloride
- 2) Kinetics of the saponification of ethyl acetate
- 3) Titration of mixture of HCL and acetic acid
- 4) Determination of solubility of barium sulphate at different temperatures

II) POTENTIOMETRY

- 1) Estimation of halides in a binary mixture
- 2) Stability constant of complex ion
- 3) pK of weak monobasic acid
- 4) Determination of enthalpy change, entropy change and equilibrium constant of reaction between metallic zinc and copper ions in solution

III) pH-METRY

- 1) Titration of phosphoric acid solution against an alkali and to determine the ionization constants of the acid
- 2) Determination of Hammett constant of given substituted benzoic acid
- 3) Determination of amount of aspirin in the given tablet

IV) COLORIMETRY

- 1) pK value of an acid-base indicator
- 2) Copper ion-EDTA titration
- 3) Analysis of a mixture of Co^{++} and $NiCr^{+++}$

V) RADIOACTIVITY

- 1) Determination of E_{max} of beta radiation and absorption coefficients in aluminum.

VI) CHEMICAL KINETICS

- 1) Kinetic of decomposition of diacetone alcohol by dilatometry
- 2) Determination of the order of reaction by fractional change method
- 3) Verification of Bronsted primary salt effect
- 4) Investigation of the auto-catalytic reaction between potassium permanganate and oxalic acid.

VII) NON-INSTRUMENTAL

- 1) Transport numbers of H^+ and Cl^- ions by moving boundary method

VIII) POLAROGRAPHY

- 1) Determination of half wave potential and unknown concentration of Cd^{++} / Zn^{++} ion.

Note : Each student should complete minimum of 18 experiments with atleast one experiment from each technique.

REFERENCES :

1. Experiments in Physical Chemistry (Pergamon Publication)
By Wilson, Newcombe, Denaro, Rickett
2. Advanced Practical Physical Chemistry (Goel Publ. House)
By J.B.Yadav
3. Practical Physical Chemistry
By Findlay
4. Systematic Experimental Physical Chemistry (Anjali Publ.)
By Rajbhoj and Chondhekar
5. Experiments in Chemistry (Himalaya Publ. House)
By D.V.Jahagirdar

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