C. U. SHAH UNIVERSITY

WADHWAN CITY

FACULTY OF SCIENCE

M.Sc.

CHEMISTRY

SEM-I & II

Syllabi (CBCS) of Chemistry (Core)

C. U. SHAH UNIVERSITY

FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

COURSE: M.Sc. **SEMESTER: I**

SUBJECT NAME:INORGANIC CHEMISTRY **SUBJECT CODE: MSCCHC101**

Teaching & Evaluation Scheme:-

Teaching Scheme(hrs)				Evaluation Scheme								
				Theory					Practical (Marks)			
Th	Seminar	Pr	Total	Sessional Exam		University Exam		Total	External	Internal	Total	Total
				Marks	Hrs	Marks	Hrs					
3	0	0	3	30	1.5	70	3	100	--	--	--	100

Objectives:-

- To get an idea about the structure and bonding affects to the physical properties and reactivity of inorganic compounds.
- To learn the theories of bonding as well as their advantages and disadvantages.
- To be able to identify symmetry elements in molecules and assign molecules to the appropriate point group.
- To learn how structures are determined for inorganic molecules and to learn about the thermodynamics of crystal lattice formation.
- To gain an appreciation for how inorganic chemistry influences your everyday life.

Prerequisites:-

Before studying Inorganic chemistry, all students have basic knowledge of inorganic and organic compounds, molecular structure, Molecular orbital theories and knowledge related to UG level chemistry.

Course outline:-

Sr. No.	Course Contents
1	**Introductions to Quantum Chemistry and its applications:** Applications of Quantum Mechanics to simple systems, LCAO-Mo and Valence Bond treatments ofH_2 molecule, electron Density, forces and their roles in chemical bonding.BornOppenheimer approximation, Hybridization and valence MO's of Water, Ammonia and Methane molecule.Huckel π-electron theory and its applications to Ethylene, Butadiene and Benzene. Concept of Self-consistent field method.
2	**Basics of Magneto chemistry:** Definition, Ferromagnetism, Anti-ferromagnetism, Ferrimagnetisms, Diamagnetism and Pascal's Constant, Russell-Saunders (RS) or LS Coupling, Relations between Multiple width to kT, Stereo chemical applications of Magnetic Properties of the First Transition Series, Lanthanides and actinides, Determination of magnetic susceptibility by Gouy's Method, Derivation of Van Vleck formula for Susceptibility.
3	**Mössbauer spectroscopy:** Introduction and Schematic Diagram of Mossbauer Spectrophotometer,Principle and Instrumentation of MössbauerSpectra, Applications, Quadrupole splitting. Recoil energy, Doppler effect. Experimental techniques. Chemical Shift.
4	**Applications of Inorganic reagents in Inorganic analysis:** The uses of some inorganic reagents: Potassium Bromate ($KBr0_3$), Potassium Iodate($KI0_3$), Ammonium Vanadate (NH_4VO_3), Ceric Suphate [$Ce(S0_4)_2$], Ethylenediamine Tetra Acetic Acid (EDTA).
5	**Uses of Organic reagents in inorganic analysis:** Cupferron, DMG, dithiozone, aluminon, oxine, dithiooxamide, a-benzoinoxime, a-nitro-(3-naphthol, a-nitrosoj3naphthol, diphenylcarbazone, diphenylcarbazide, anthranilic acid, tannin, pyragallol, benzidine. salicylaldoxime, o-phenanthroline.

Learning Outcomes:-

After the successful completion of the course, students will be able to

- Learn basic concepts of quantum chemistry and its applications.
- Understanding of magnetic properties, stereo chemical applications and other theoretical concepts.
- They can get idea of Mössbauer spectroscopy and its experimental techniques.
- Aware about general properties and uses of organic and inorganic reagents in inorganic chemistry.

Books Recommended:-

1. Introduction to Magnetochemistry, Alan Earnshaw, Academic Press.
2. Elements of Magnetochemistry, Shyamal&Datta East- West Press.

3. Introduction to Quantum Chemistry, A K Chandra, McGraw-Hill.
4. Advanced Inorganic Chemistry, Cotton Wilkinson, W S E Wiley.
5. Physical Methods in Chemistry, R.S.Drago , Saunders Colelge.
6. Vogel's Text book of Quantitative Inorganic Analysis, ELBS Press.
7. Quantum Chemistry, Ira N. Levine, Prentice-Hall International.
8. Textbook of Inorganic Chemistry Vol.I& II, A.Singh&R.Singh, Campus.

E-Resources:-

1. http://pubs.acs.org/journal/inocaj
2. http://www.chemlin.de/chemistry/inorganic_chemistry.htm
3. http://www.anorg.chem.uu.nl/home/index.html
4. http://www.springer.com/chemistry/inorganic+chemistry/journal/11502
5. http://libguides.stanford.edu/content.php?pid=149720&sid=1271547
6. http://www.science.uwaterloo.ca/~cchieh/cact/applychem/inorganic.html
7. http://pubs.rsc.org/en/journals/journalissues/ic#!recentarticles&all
8. http://www.chem.umass.edu/~samal/orginorgsites.html
9. http://www.sciencedirect.com/science/book/9780123851109
10. http://www.chemistryviews.org/details/event/1442119/2nd_EuCheMS_Inorganic_Chemistry_Conference.html
11. http://store.elsevier.com/Comprehensive-Inorganic-Chemistry-II/isbn-9780080977744/
12. http://chemistry.about.com/cs/generalchemistry/a/aa072103a.htm
13. http://www.ox.ac.uk/admissions/postgraduate_courses/course_guide/chemistry_1.html
14. http://www.researchgate.net/journal/0260-3594_Comments_on_Inorganic_Chemistry
15. http://www.cecam.org/workshop-671.html

C. U. SHAH UNIVERSITY

FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

COURSE: M.Sc. **SEMESTER: I**

SUBJECT NAME: ORGANIC CHEMISTRY **SUBJECT CODE: MSCCHC102**

Teaching & Evaluation Scheme:-

Teaching Scheme(hrs)				Evaluation Scheme								
				Theory					Practical (Marks)			
Th	Seminar	Pr	Total	Sessional Exam		University Exam		Total	External	Internal	Total	Total
				Marks	Hrs	Marks	Hrs					
3	0	0	3	30	1.5	70	3	100	--	--	--	100

Objectives:-

- To understand reaction mechanism in organic synthesis.
- To learn theories and principles related to organic chemistry.
- To learn various nucleophilic and electrophilic reactions in organic chemistry.
- To create an interest of students to learn organic chemistry.

Prerequisites:-

Before studying Inorganic chemistry, all students have basic knowledge of inorganic and organic compounds, molecular structure, Molecular orbital theories and knowledge related to UG level chemistry.

Course outline:-

Sr. No.	Course Contents
1	**Reaction path way and effect of structure on reactivity**: Homolytic and Heterolytic fission, different types of arrow notation, Electrophile and Nucleophile, Linear free energy relationships (LFER), the Hammett equation- substituent and reaction constants, the Taft treatment of polar and stearic effects in aliphatic compounds.
2	**Organic Name Reactions:** **(I) Nucleophilic C-C bond formation** 1. Aldol condensation, 2. Horner-Wordwoth-Emmons reaction, 3. Mukaiyama reaction, 4. Wittig reaction.

3	**(II) Electrocyclic C-C bond formation** 1. Nazarov cyclization, 2. Prins reaction, 3. Vilsmeier- Haack reaction, 4. Noyari reaction, 5. Stille coupling
4	**(II) Miscellaneous reactions** 1.Barbier-Wieland, 2. Barton, 3. Birch, 4. Bouveault, 5. ChiChiBabin 6. Clemmensen, 7. Elbs-persulphate, 8. Darzen, 9. Hantzsch, 10. Hofmann-Loffler Freytag, 11. Hydroboration, 12. Grubb's reaction, 13. Knoevenagel, 14. Leukart, 15. Michael addition, 16. MaMarryolefination, 17. Mitsonobu reaction, 18. Oppenauer, 19. Passerini reaction, 20. Perkin, 21. Reformatsky, 22. Robinson annulation, 23. Rosenmund, 24. Shapiro, 25. Sharplessasymetricepoxidation, 26. Stobbe, 27. Storkeenamine, 28. Suzuki coupling, 29. Ugi reaction, 30. Vilsmeier- hack,.,31. Wolff Kishner, 32.Wilgerodt.
5	**Rearrangements:** Reaction mechanism–nature of migration, migratory aptitude, memory effects. A detailed study of the following rearrangements: Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Curtius, Schmidt, Baeyer-villiger. Applications.
6	**Uses of Selected Reagents:** Dess martin periodinane, Sodium cyanoborohydride, Lithium diisopropylamide, Crown ethers and Merrifield resin, Dicyclohexylcarbodiimide, Trimethylsilyl iodide, Peterson's synthesis, BBN, IBX, Ceric ammonium nitrate, Lithium dimethylcuprate, Wilkinson's catalyst, Phase transfer catalyst, Woodward and Prevost hydroxylation,

Learning Outcomes:-

After the successful completion of the course, students will be able to understand

- Organic reaction pathways.
- Nucleophilic and electrophilic reaction mechanisms and rearrangements reactions.

Books Recommended:-

1. Reaction Mechanism and Problems in Organic Chemistry – P. Chattopadhyay, Asian Book Pvt Ltd, New Delhi (2003).
2. A Text Book of Organic Chemistry – R.K.Bansal, New Age International (P) ltd. 4th edition (2003).
3. Advanced Organic Chemistry, Part B – F. A. Carey & R. J. Sundberg, Plenum Press (2007).
4. Organic Chemistry by G. Marc. Loudon, Oxford University Press (2002).
5. Organic Reaction Mechanism (II edition) – V.K. Ahluwalia, R.K. Parasar.
6. Reaction Mechanism and Reagents in Organic Chemistry – Gurdeep R. Chatwal.
7. Organic Chemistry by Morrission and Boyd, prentice hall of India pvt ltd (6th edition), (2003)
8. Organic Chemistry – I.L.Finar 6th edition (low price), Pearson Education (2003).
9. Advanced Organic Chemistry (IV edition) – Jerry March.
10. Reactive Intermediates in Organic Chemistry – J.P. Trivedi, University granthNirman Board.

11. Organic Chemistry by T.W. Graham solimn, Craig B. Fryble, low price 8th edition, John Wiley & Sons, inc.
12. Organic Chemistry by V.K.Ahluwalia, MadhuriGoyal, Narosa Publishing House, (2000).
13. Organic Synthesis (2nd edition) by M.B. Smith, Mcgraw-Hill, Inc. (2001).
14. Some Modern Methods of Organic synthesis (4th edition), W.Carruthers, Cambridge University Press (2004).
15. Organic Cehmsitry – Structure and Reactivity by SeyhanEge, A.I.T.B.S. Publishers and Distributors. 3rd edition (1998).
16. Organic Chemistry by J. Mcmurry, Asian Books Pvt. Ltd., 5th edition (2001). Organic Synthesis – Strategy and Control by Paul Wyatt & Stuart Warren, John Wiley & Sons, (2007).
17. Principles of Organic Synthesis by R.O.C Norman, J.M. Coxon, CRC Press, (3rd edition) (2009).
18. Organic Chemistry by J. Clayden, N. Greeves, S. Warren, P. Wothers, Oxford University Press (2000).
19. Comprehensive Organic Synthesis, Vols 1-9, B.M. Frost & I Fleming. Pergamon (1991).

E-Resources:-

1. http://www.organic-chemistry.org/
2. http://www.organicdivision.org/?nd=p_organic_web_links
3. http://www.masterorganicchemistry.com/resource-guide/
4. http://orgchem.iisc.ernet.in/chemlink.html
5. http://www.mpcfaculty.net/ron_rinehart/organic.htm
6. http://web.usca.edu/chemistry/NewStudentInfo/helpful-websites-for-studying-organic-chemistry.dot
7. http://pubs.rsc.org/en/journals/journalissues/oc#!recentarticles&all
8. http://www.chem.ox.ac.uk/vrchemistry/iom/#
9. http://ocw.mit.edu/courses/#chemistry
10. http://www.stolaf.edu/depts/chemistry/courses/toolkits/247/
11. http://iverson.cm.utexas.edu/courses/310M/MainPagesSp06/GoldenRules.html
12. http://www.abdn.ac.uk/curly-arrows/index.html%20(click%20the%20Tutorials%20button)
13. www.wikipedia.org/organic

C. U. SHAH UNIVERSITY

FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

COURSE: M.Sc. **SEMESTER: I**

SUBJECT NAME: PHYSICAL CHEMISTRY **SUBJECT CODE: MSCCHC103**

Teaching & Evaluation Scheme:-

Teaching Scheme(hrs)				Evaluation Scheme								
				Theory					Practical (Marks)			
Th	Seminar	Pr	Total	Sessional Exam		University Exam		Total	External	Internal	Total	Total
				Marks	Hrs	Marks	Hrs					
3	0	0	3	30	1.5	70	3	100	--	--	--	100

Objectives:-

- To understand concept and theories of physical chemistry.
- To get idea about chemical reaction, equilibrium and electrode potential.
- To understand applications of physical chemistry in daily life.
- To generate interest and curiosity about physical chemistry.

Prerequisites:-

Before learning Physical chemistry, student should aware about basic principles and theories of physical chemistry, thermodynamics, electrode potential, chemical reactions and other UG level chemistry.

Course outline:-

Sr. No.	Course Contents
1	**Basics of Thermodynamics**: Terms of probability, cell, phase space, micro and macro states, thermodynamic probability, statistical weight factor, assembly, ensemble and its classification and statistical equilibrium. Derivation of Boltzmann-Maxwell, Bose-Einstein and Fermi- Dirac statistics, Partition function and derivations of translational, rotational, vibrational and electronic partition functions and thermodynamic functions such as internal energy, heat capacity, entropy, work function, pressure, heat content, etc. Partition function and third law of thermodynamics. Applications of partition function to monoatomic gases, diatomic molecules, equilibrium constant and equilibrium constants of metathetic reactions. Problems.
2	**Fugacity and Activity:**Definition of Fugacity. Graphical Method. Equation of State Method. Approximate Method. Generalized Method. Variation of Fugacity with Temperature and Pressure. Fugacity of Solids and Liquids. Mixture of Ideal Gases. Mixture of Real Gases. Determinations of Fugacity in Gas Mixtures (The Lewis-Randall Rule). Problems.
3	**The Debye-Huckel Theory:** Ionic interactions in solutions. Electrical potential of ionic atmosphere. Electrical free energy and activity coefficients. Mean ionic activity coefficients (D-H limiting law).Applications of D-H theory: quantitative and qualitative, solubility in presence of added electrolyte and osmotic coefficient. The DH theory in more concentrated solutions. D-H theory and equilibrium constant. Problems.
4	**Types of solutions and their properties**:Composition of liquid and vapor in equilibrium influence of temperature on gas solubility and solid-liquid equilibrium. Ideal solutions: Properties, the DuhemMargules equation, vapor pressure curves. **Non ideal solutions:**General equations for liquid mixtures. Partially miscible liquids. Deviation from ideal behavior, vapor pressure curves, Liquid and vapor compositions. **Dilute solutions:**Determination of molecular weight by freezing and boiling point methods. Henry's law. Problems.
5	**Free energy and Chemical reactions: Chemical equilibrium and the equilibrium constant:**Chemical Equilibrium. The Equilibrium Constant. Equilibrium in Homogeneous Gaseous Systems. The Ammonia Equilibrium. Homogeneous Reactions in Liquid Solutions and Dilute Solutions. The Reaction Isotherm. Standard Free Energy of Reaction. The Direction of Chemical Change. Variation of Equilibrium Constant with Pressure and Temperature. Integration of Van't Hoff Equation. Variation of Standard Free Energy with Temperature. Determination of Standard Free Energies. Standard Free Energies and Entropy changes. Application of Free Energy and Entropy data. Equilibrium Constants of Metathetic Reactions. Problems.
6	**Applications of electrode potentials and thermodynamics of ions in solutions**: The dissociation constants of water and weak acids. Free energies of formation of ions. Calculations of equilibrium constants and solubility products from standard potentials. Dissociation pressures. Standard entropies of ions and applications. Standard heats of formation of ions. Examples.

Learning Outcomes:-

After the successful completion of the course, students will be able to

- Understand Thermodynamics and its applications.
- Concept of fugacity and its determination.
- Understand about solutions, its properties and vapor pressure curves.
- They can be able to apply basics into their experiment as well as their routine life.

Books Recommended:-

1. Thermodynamics for Chemists by Samuel Glasstone.
2. Thermodynamics by Gurdeep and Rajesh.
3. Statistical Thermodynamics by L. K. Nash.

E-Resources:-

1. http://ukcatalogue.oup.com/product/9780199543373.do#.UhOsGtI3Bsk
2. http://web.mit.edu/speclab/www/links.html
3. http://library.duke.edu/research/subject/guides/chemistry/
4. http://www.chem.ox.ac.uk/cheminfo/internet.html
5. http://www.science.fau.edu/chemistry/links.htm
6. http://pubs.rsc.org/en/journals/journalissues/cp#!recentarticles&all
7. http://www.rsc.org/ConferencesandEvents/ISACS/PhysicalChemistryandNanoscience/index.asp
8. http://pubs.acs.org/loi/jpchax
9. http://www.csulb.edu/~lhenriqu/chem.htm
10. http://libguides.stanford.edu/content.php?pid=114712&sid=991132
11. http://simple.wikipedia.org/wiki/Physical_chemistry
12. http://chemistry.olivet.edu/chemistry_library.htm
13. http://as.wiley.com/WileyCDA/WileyTitle/productCd-EHEP000800.html
14. http://www.chemsoc.dk/KFlinks.htm
15. http://www.library.auckland.ac.nz/subject-guides/chem/chemmeta.htm
16. http://www.tandfonline.com/toc/trpc20/current#.UhOsT9I3Bsk

C. U. SHAH UNIVERSITY

FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

COURSE: M.Sc. **SEMESTER: I**

SUBJECT NAME: ANALYTICAL CHEMISTRY **SUBJECT CODE: MSCCHC104**

Teaching & Evaluation Scheme:-

Teaching Scheme(hrs)				Evaluation Scheme								
				Theory					Practical (Marks)			
Th	Seminar	Pr	Total	Sessional Exam		University Exam		Total	External	Internal	Total	Total
				Marks	Hrs	Marks	Hrs					
3	0	0	3	30	1.5	70	3	100	--	--	--	100

Objectives:-

- To learn about analytical instrumentation and their applications in analytical chemistry.
- To understand fundamentals of analytical chemistry and its laboratory applications.
- Aware about spectroscopy and its various techniques.

Prerequisites:-

Before learning analytical chemistry, student should aware about basic principles and theories of analytical chemistry, instrumental methods of analysis and other UG level chemistry.

Course outline:-

Sr. No.	Course Contents
1	**Introduction to Analytical Chemistry** Definition of analytical chemistry. The role of analytical chemistry, Classification of analytical techniques: classical and instrumental. Importance of analytical chemistry in human life.

2	**Fundamentals of quantitative chemical analytical techniques** **a.** Sampling of solid liquid and gas. **b.** Classical and instrumental techniques with their advantages and disadvantages. **c.** Factors affecting the analytical method selection and use. **d.** Law of mass action and ionization product of water **e.** Factors affecting chemical reactions in solution **f.** Electrolytic dissociation **g.** Solubility product and Common ion effect **h.** Theory and applications of precipitation, redox, complexomatric and neutralization techniques **i.** Various concentration units with calculation **j.** Preparation, standardization of solutions, reagents, primary and secondary standards. **k.** Errors and error minimization
3	**Food analysis:** Determination of Moisture, ash, crude, protein, fat, crude-fiber, carbohydrate, Ca, K, Na and PO_4, Oil and fat in food samples.
4	**Flamephotometry and atomic absorption spectroscopy:** Principle, theory, instrumentation, sample handling and applications.
5	**Flourimetry and Phosphorimetery:** Principle,Jablonski diagram, instrumentation, sample handling and applications.
6	**Turbidimetery and Nephelometery:** Principles, theory, instrumentation, sample handling and applications.
7	**UV-Visible Spectrophotometry:** Brief review of electromagnetic spectrum and absorption of radiations. The chromophore concept, absorption law and limitations. Theory of electronic spectroscopy, absorption by organic molecules, choice of solvent and solvent effects. Applications of UVVisible spectroscopy, Woodward –Fischer rules for calculating absorption maximum, interpretation of spectra, multi-component assay, difference spectra and derivative spectra.

Learning outcomes:-

After the successful completion of the course, students will be able to

- Learn basic analytical techniques and instrumental methods.
- Understand and implement spectroscopic techniques for quantitative analysis.
- Identify and determine food components.

Books Recommended:-

1. Analytical Chemistry. Principles – J. K. Kennedy and W. B. Saunders.
2. Fundamentals of analytical chemistry. D. A. Skoog, D. M. West, F. J. Holler and Crouch.
3. Instrumental Methods of Chemical Analysis.B. K. Sharma.
4. Quantitative Analysis. R. A. Day Jr. And A. L. Underwood.
5. Analytical Chemistry.- G. D. Christian.
6. Food Analysis. S. N. Mahindru.
7. Vogel's Textbook of quantitative Inorganic Analysis – L. Barrtet. al. ELBS.

E-Resources:-

1. http://ukcatalogue.oup.com/product/9780199543373.do#.UhOsGtI3Bsk
2. http://web.mit.edu/speclab/www/links.html
3. http://library.duke.edu/research/subject/guides/chemistry/
4. http://www.chem.ox.ac.uk/cheminfo/internet.html
5. http://www.science.fau.edu/chemistry/links.htm
6. http://pubs.rsc.org/en/journals/journalissues/cp#!recentarticles&all
7. http://www.rsc.org/ConferencesandEvents/ISACS/PhysicalChemistryandNanoscience/index.asp
8. http://pubs.acs.org/loi/jpchax
9. http://www.csulb.edu/~lhenriqu/chem.htm
10. http://libguides.stanford.edu/content.php?pid=114712&sid=991132
11. http://simple.wikipedia.org/wiki/Physical_chemistry
12. http://chemistry.olivet.edu/chemistry_library.htm
13. http://as.wiley.com/WileyCDA/WileyTitle/productCd-EHEP000800.html
14. http://www.chemsoc.dk/KFlinks.htm
15. http://www.library.auckland.ac.nz/subject-guides/chem/chemmeta.htm
16. http://www.tandfonline.com/toc/trpc20/current#.UhOsT9I3Bsk

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FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

COURSE: M.Sc. **SEMESTER: I**

SUBJECT NAME: PRACTICALS **SUBJECT CODE: MSCCHC105**

Teaching & Evaluation Scheme:-

Teaching Scheme(hrs)				Evaluation Scheme								
				Theory					Practical (Marks)			
Th	Seminar	Pr	Total	Sessional Exam		University Exam		Total	External	Internal	Total	Total
				Marks	Hrs	Marks	Hrs					
0	0	15	15	--	--	--	--	--	150	50	200	200

Course outline:-

Sr. No.	Course Contents
1	**Organic Chemistry:** **a.** **Organic preparation(10):**One &Two stage preparation. **b.** Identification of Organic compounds containing more than one functional groups **(05)**
2	**Inorganic Chemistry:** **a.** **Qualitative Analysis:** Analysis of a mixture containing six radicals, including one less common metal ions: W, Tl, Ti, Mo,Se, Zr, Th, Ce,V, Li. **b.** **Synthesis and estimation of metal complexes:**Synthesis of selected inorganic metal complexes(04) and their estimation by usual volumetric /gravimetric /colorimetric techniques to determine the percentage purity of the complexes prepared:
3	**Physical Chemistry:** **(i) Instrumental exercises:** **a.** Conductometry: Mono and biprotic acids, mixtures of acids against strong/weak bases, argentometric, complexometric, replacement titrations, verification of Onsagar's equation, dissociation of weak acids. **b.** Potentiometry: acid-base, redox and argentometric titrations. **c.** pHmetry: acid-base titration, pKa of acids and E0QH2. **d.** Ultrasonics: Acoustical parameters of liquids. **e.** Refractometry: Binary mixtures and solids. **f.** Polarimetry: Optically active compounds.

	g. Spectrophotometry: Lambert-Beers Law, binary mixture, kinetics of iodination, etc. **(ii) Physicochemical exercises**: **a. Reaction dynamics**: Zero, first and second order reactions. **b. Partition coefficient**: Dimerization of acids, I^--I_2 system, Cu^{2+} - NH_3 complexes. **c. Thermodynamics**: Heat of solution, partial molar volume, etc. **d. Steam distillation**: Molecular weight determination.
4	**Analytical Chemistry**: **a. Practicals based on food analysis**: Honey, oil, tea-leaves, turmeric powder, etc. **b. Drug analysis**: aspirin, Benzyl benzoate, etc. **c. Volumetric and gravimetric exercises**: Ester, peroxides, other ions, etc. **d. Industrial products**: Estimation for purity and assay.