

**Vivekanand College, Kolhapur (Autonomous)**  
**Department of Chemistry**  
**B.Sc. Part - I Syllabus (CBCS Pattern)**  
**In force from June -2018**

## **INTRODUCTION**

This syllabus is prepared to give the sound knowledge and understanding of chemistry to undergraduate students at first year of the B.Sc. degree course. The goal of the syllabus is to make the study of chemistry as stimulating, interesting and relevant as possible. The syllabus is prepared by keeping in mind the aim to make students capable of studying chemistry in academic and industrial courses. Also to expose the students and to develop interest in them in various fields of chemistry. The new and updated syllabus is based on disciplinary approach with vigour and depth taking care of the syllabus is not heavy at the same time it is comparable to the syllabi of other universities at the same level.

The syllabus is prepared after discussions of number of faculty members of the subject and by considering the existing syllabi of B.Sc. Part-I, II & III, XI<sup>th</sup> & XII<sup>th</sup> standards, NET, SET examination, U.G.C. model curriculum, different entrance examinations, other Universities and other autonomous institutes.

The units of the syllabus are well defined and the scope is given in detail. The periods required for units are given. The lists of reference books are given in detail.

## OBJECTIVES

To enable the students

- To promote understanding of basic facts and concepts in Chemistry while retaining the excitement of Chemistry.
- To make students capable of studying Chemistry in academic and Industrial courses.
- To expose the students to various emerging new areas of Chemistry and apprise them with their prevalent in their future studies and their applications in various spheres of chemical sciences.
- To develop problem solving skills in students.
- To expose the students to different processes used in Industries and their applications.
- To develop ability and to acquire the knowledge of terms, facts, concepts, processes, techniques and principles of subjects.
- To develop ability to apply the knowledge of contents of principles of chemistry.
- To inquire of new knowledge of chemistry and developments therein.
- To expose and to develop interest in the fields of chemistry.
- To develop proper aptitude towards the subjects.
- To develop the power of appreciations, the achievements in Chemistry and role in nature and society.
- To develop interest in students to study chemistry as a discipline.
- To develop skills required in chemistry such as the proper handling of apparatus and chemicals.

### List of Laboratory equipments & Chemicals required

Apparatus & equipments and chemicals required.

Viscometer	Measuring cylinder	Wire gauze	Burette stand
Stop watch	Stopper bottle	Burner	Iron stand
Eudiometer	Test tube, Beaker	Water bath	Test tube holder
Digital balance	Thiele's tube	Chromatography paper	Test tube stand
Burette, pipette and conical flask	Capillary tube	Gas jar	Spot tile
1/100C thermometer	Evaporating dish	Watch glass	Dropper
Polythene bottles	Glass rod	Tripod stand	Dryer

# General Structure

There will be one theory paper for each semester of 80 marks and internal examination of 20 marks.

## Semester I

**Paper I: Inorganic and Organic Chemistry** **80 Marks**

## Semester II

**Paper II: Physical and Organic Chemistry** **80 Marks**

There will be annual practical examination. Practical will be of 50 marks. Physical, Inorganic and Organic sections carry 15 marks each. Five marks are reserved for journal. The duration of practical examination will be of six hours.

**Vivekanand College, Kolhapur**  
**B. Sc. Part-I (Chemistry) CBCS Syllabus with effect from June, 2018**  
**Semester-I, Chemistry Paper-I**  
**Chemistry-DSC-1002A: Inorganic and Organic Chemistry**  
**Theory: 60 hrs (75 Lectures) Credits-4**

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**Section I: Inorganic Chemistry (37 Periods)**

**Unit I Atomic Structure (10 Periods)**

- 1:1 Bohr's theory of hydrogen atom and its limitations
- 1:2 Dual behaviors of matter and radiation
- 1:3 De Broglie's relation
- 1:4 Heisenberg's Uncertainty principle
- 1:5 Introduction to Quantum mechanics, Schrodinger wave equation. (Final equation only)
- Significance of  $\psi$  and  $\psi^2$ ,
- 1:6 Quantum numbers and their Significance
- 1:7 Shapes of *s*, *p*, *d* and *f* atomic orbital's
- 1:8 Electrons filling Rules in various orbital's, A) Aufbaus principle B) Hund's rule of maximum multiplicity C) Pauli's exclusion principle
- 1:9 Electronic configurations of elements, Stability of empty, half-filled and completely filled orbital's

**Unit –II Periodicity of elements (07 Periods)**

- 2:1 Introduction,
- 2:2 General discussion of the following properties of the elements with reference to 's' and 'p' block elements (oxygen and nitrogen family) a) Electronic configuration b) Atomic radii c) Ionic radii d) Ionization energy e) Electron affinity f) Electronegativity g) Metallic characters h) Reactivity i) Oxidation state j) melting and boiling points k) chemical properties
- 2:3 Oxoacids of nitrogen, phosphorus and sulphur ( $\text{HNO}_2$ ,  $\text{HNO}_3$ ,  $\text{H}_3\text{PO}_3$ ,  $\text{H}_3\text{PO}_4$ ,  $\text{H}_2\text{SO}_3$ ,  $\text{H}_2\text{SO}_4$ )

**Unit –III: Ionic Bonding****(06 Periods)**

- 3.1 Definition and formation of ionic bond. General characteristics of ionic bonding
- 3.2 Energetic in Ionic bond formation
- 3.3 Born-Haber cycle for NaCl and its applications.
- 3.4 Polarizing power and polarizability.
- 3.5 Fajan's Rule.
- 3.6 Ionic character in covalent compounds.
- 3.7 Bond moment, dipole moment and percentage ionic character.

**Unit –IV: Covalent bonding -Valence Bond Theory (VBT)****(07 Periods)**

- 4.1 Valence Bond Theory: Introduction, Assumptions, Applications and Limitations.
- 4.2 Concept of hybridization, different types of hybridization and geometry of molecule.
  - Linear geometry  $\text{BeCl}_2$  ( sp hybridization )
  - Planer trigonal geometry  $\text{BF}_3$  ( $\text{sp}^2$  hybridization )
  - Tetrahedral geometry  $\text{SiCl}_4$  ( $\text{sp}^3$  hybridization)
  - Trigonal bipyramidal geometry  $\text{PCl}_5$  ( $\text{sp}^3\text{d}$  hybridization )
  - Octahedral geometry  $\text{SF}_6$  (  $\text{sp}^3\text{d}^2$  hybridization )
  - Pentagonal bipyramidal geometry( $\text{IF}_7$ ) (  $\text{sp}^3\text{d}^3$  hybridization )
- 4.3 Valence Shell Electron Pair Repulsion (VSEPR) Theory  $\text{H}_2\text{O}$ ,  $\text{ClF}_3$ ,  $\text{ICl}_4^-$

**Unit –V: Molecular orbital theory (MOT)****(07 Periods)**

- 5.1 Introduction: Atomic Orbital's and Molecular Orbital's, LCAO method, formation of bonding, anti bonding and nonbonding molecular orbitals.
  - 5.2 conditions of successful overlap,
  - 5.3 Types of overlaps - S-S, S-P<sub>x</sub>, P<sub>x</sub>-P<sub>x</sub>, P<sub>y</sub>-P<sub>y</sub>/ P<sub>z</sub>-P<sub>z</sub> overlaps.
  - 5.4 Bond order and its significance.
  - 5.5 Energy level sequence for molecular orbital when n=1&2.
  - 5.6 MO diagrams for homonuclear diatomic molecules of 1<sup>st</sup> & 2<sup>nd</sup> period elements ( $\text{He}_2$ ,  $\text{Li}_2$ ,  $\text{B}_2$ ,  $\text{N}_2$ ,  $\text{O}_2$ ).
  - 5.7 Molecular orbital diagrams for heteronuclear diatomic molecules. ( $\text{CO}$ ,  $\text{NO}$ ,  $\text{NO}^+$ )
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## Reference Books

- 1) Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
  - 2) Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
  - 3) Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
  - 4) Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India, 2006.
  - 5) Puri, Sharma, Kalia. *Principles of Inorganic Chemistry*
  - 6) Suratkar and Thatte. *Theoretical Inorganic Chemistry*
  - 7) Day and Sellbin. *Theoretical Inorganic Chemistry*
  - 8) R Gopalan & Ramalingum. *Coordination Chemistry*
  - 9) Satyaprakash, tuli and madan. *Advanced Inorganic Chemistry*
  - 10) Huheey, J.E. *Principles of Structure and Reactivity*.
  - 11) Huheey, J.E *Inorganic Chemistry*
  - 12) Gary Meissler and Donald Tarr. *Inorganic Chemistry*
  - 13) D.F.Shriver & P.W. Atkins *Inorganic Chemistry*
  - 14) E. S. Gilreath. *Fundamental Concepts of Inorganic Chemistry*
  - 15)
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## **Section II: Organic Chemistry (38 Periods)**

### **Unit I: Fundamentals of Organic Chemistry (09 Lectures)**

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases.

### **Unit II: Stereochemistry (10 Lectures)**

Conformations with respect to ethane, butane and cyclohexane, Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations, Concept of chirality (upto two carbon atoms), Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; *cis-trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems)

### **Unit III: Alkanes (Upto 5 Carbons). (06 Lectures)**

*Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation

### **Unit IV: Alkenes (Upto 5 Carbons) (07 Lectures)**

*Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's Rule); *cis* alkenes (Partial catalytic hydrogenation) and *trans* alkenes (Birch reduction). *Reactions:* *cis*-addition (alk.  $\text{KMnO}_4$ ) and *trans*-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

## Unit V: Alkynes (Upto 5 Carbons)

(06 Lectures)

*Preparation:* Acetylene from  $\text{CaC}_2$  and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. *Reactions:* formation of metal acetylides, addition of bromine and alkaline  $\text{KMnO}_4$ , ozonolysis and oxidation with hot alk.  $\text{KMnO}_4$ .

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### Reference Books

- 1) Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
- 2) McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- 3) Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
- 4) Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
- 5) Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
- 6) Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
- 7) Tiwari, Vishnoi Textbook of Organic Chemistry.
- 8) R. K. Bansal Textbook of Organic Chemistry.
- 9) E. S. Gould Mechanism and structure in organic chemistry.
- 10) Bhal and Bhal Textbook of Organic Chemistry
- 11) Jerry March Advanced Organic Chemistry
- 12) Phatak, Mahagani, Modern Organic Chemistry
- 13) G.R. Chatwal, reaction Mechanism and reagents in Organic Chemistry
- 14) Stereochemistry by P. S. Kalsi (New Age International)
- 15) Organic Chemistry- Clayden, Greeves, Warren.
- 16) Reaction and rearrangement- S. N. Sanyal.
- 17) Organic Reaction Mechanism- V. K. Ahluwalia.
- 18) Advanced Organic Chemistry- Jagdamba Singh.



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**Vivekanand College, Kolhapur (Autonomous)**  
**B. Sc. Part-I (Chemistry) CBCS Syllabus with effect from Jun 2018**  
**Semester I Chemistry Paper II**  
**Chemistry-DSC-1002B: Physical and Organic Chemistry**  
**Theory 60 hrs (75 Lectures) Credits-4**

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**Section I: Physical Chemistry (38 Lectures)**

**Unit -I: Chemical Energetics (10 lectures)**

Introduction, Enthalpy of reaction, standard enthalpy changes, various types of enthalpy changes viz, enthalpy of formation, enthalpy of neutralization, enthalpy of ionization, enthalpy of solution (integral and differential enthalpy of solutions), enthalpy of hydration, enthalpy of phase transitions; Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, Variation of enthalpy of reaction with temperature- Kirchoff,s equation.

**Unit II: Thermodynamics (05 lectures)**

Spontaneous and non spontaneous process with examples, Statements of second law of thermodynamics, Carnot's cycle and its efficiency,

**Unit III: Entropy and Third law (08 lectures)**

Concept of entropy, physical significance of entropy, entropy as a state function of V & T, P & T, entropy of mixing of gases, entropy change accompanying phase transition, Third law of thermodynamics, calculation of absolute entropies.

**Unit IV: Chemical Equilibria (10 lectures)**

Concept of free energy, Free energy change in a chemical reaction, Thermodynamic derivation of the law of chemical equilibrium. Distinction between  $\Delta G$  and  $\Delta G^\circ$ , Le Chatelier's principle, Condition for maximum yield in industrial processes like manufacture of ammonia, and sulphuric acid, Relationships between  $K_p$ ,  $K_c$  and  $K_x$  for reactions involving ideal gases.

**Unit V: Ionic Equilibria (05 lectures)**

Strong and weak electrolytes, degree of ionization, Ionization of weak acids and bases, pH scale, Buffer solutions, common ion effect, Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

## Reference Books

- 1) Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
  - 2) Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
  - 3) Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
  - 4) Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
  - 5) Puri, Sharma, Pathania. *Principles of Physical Chemistry*.
  - 6) *Principles of Physical Chemistry* by murrone pruton.
  - 7) S.K. Dogra and Dogra. *Physical Chemistry*
  - 8) Engel and Red, *Principles of Thermodynamics*
  - 9) Peter and Atkins. *Physical Chemistry*
  - 10) Glasston and Levis *Principle of Physical Chemistry*
  - 11) Bhal & Tuli, *Physical Chemistry*
  - 12) G.M. Barrow., *Physical Chemistry* Tata McGraw-Hill (2007).
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## Section II: Organic Chemistry

(37 Lectures)

### Unit I: Aromatic hydrocarbons

(8 Lectures)

Aromaticity: Benzenoids and Hückel's rule. *Preparation* (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. *Reactions*: (Case benzene): Electrophilic substitution: Industrial preparation methods for nitration, halogenations, sulphonation, Friedel-Craft's reaction (alkylation and acylation).

### Unit II: Halides

(12 Lectures)

**Alkyl Halides** (Upto 5 Carbons) Types of Nucleophilic Substitution ( $SN^1$ ,  $SN^2$  and  $SN_i$ ) reactions. *Preparation*: from alkenes and alcohols. *Reactions*: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution. **Aryl Halides** *Preparation*: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. *Reactions (Chlorobenzene)*: Aromatic nucleophilic substitution (replacement by  $-OH$  group) and effect of nitro substituent. Benzyne Mechanism:  $KNH_2/NH_3$  (or  $NaNH_2/NH_3$ ). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

### Unit III: Alcohols, Phenols

(08 Lectures)

**Alcohols**: *Preparation*: Preparation of  $1^\circ$ ,  $2^\circ$  and  $3^\circ$  alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. *Reactions*: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk.  $KMnO_4$ , acidic dichromate, conc.  $HNO_3$ ). Oppeneauer oxidation *Diols*: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

**Phenols**: (Phenol case) *Preparation*: Cumene hydroperoxide method, from diazonium salts.

*Reactions*: Electrophilic substitution:

Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben-Hoesch Condensation, Schotten-Baumann Reaction.

### Unit IV: Ethers

(03 Lectures)

*Preparation, Reactions of ethers* Cleavage of ethers with HI.

## Unit V: Aldehydes and Ketones

(06 Lectures)

Formaldehyde, acetaldehyde, acetone and benzaldehyde) *Preparation*: from acid chlorides and from nitriles.

*Reactions* – Reaction with HCN, ROH, NaHSO<sub>3</sub>. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Ponndorf Verley reduction.

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### Reference Books

- 1) Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
  - 2) McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
  - 3) Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988)
  - 4) Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
  - 5) Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
  - 6) Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
  - 7) Organic Chemistry- Clayden, Greeves, Warren.
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# Course Structure

## B. Sc. I (Sem I & II) Chemistry

<b>B. Sc. I</b>	<b>Subject (Core Course)</b>	<b>No. of Lec.</b>	<b>Hours</b>	<b>Credit</b>
<b>Sem-I</b>	<b>Chemistry DSC-1002A: Inorganic &amp; Organic Chemistry</b>	<b>05</b>	<b>04</b>	<b>04</b>
	<b>Chemistry Lab I: DSC-1002A Chemistry</b>	<b>04</b>	<b>3.2</b>	<b>02</b>
<b>Sem-II</b>	<b>Chemistry DSC-1002B: Physical &amp; Organic Chemistry</b>	<b>05</b>	<b>04</b>	<b>04</b>
	<b>Chemistry Lab II : DSC-1002B Chemistry</b>	<b>04</b>	<b>3.2</b>	<b>02</b>

## Nature of the question paper

### B.Sc. Part I Sem I & II

#### Instructions:

- 1) *All questions are compulsory*
- 2) *Answer to the two sections should be written in separate answer books*
- 3) *Figures to the right indicate full marks*
- 4) *Draw neat diagrams and give equations wherever necessary*
- 5) *Use of scientific calculators is allowed*

**Time : 03 Hrs**

**Total Marks: 80**

#### Section I

**Q. 1** Choose the most correct alternative for each of the following and rewrite the sentence **(08)**

**Q.2** Attempt **any Two** of the following **(16)**

i)-----

ii) -----

iii)-----

**Q.3** Attempt **any Four** of the following **(16)**

i)-----

ii) -----

iii)-----

iv)-----

v)-----

## Section II

**Q. 4** Choose the most correct alternative for each of the following and rewrite the sentence (08)

**Q.5** Attempt **any Two** of the following (16)

i)-----

ii) -----

iii)-----

**Q.6** Attempt **any Four** of the following (16)

i)-----

ii) -----

iii)-----

iv)-----

v)-----

**Instruction to paper setters: Equal weightage should be given to all units.**

**For continuous internal examination: 20 Marks**

**Mandatory 1) Attendance: 05 Marks**

**\*Select any one -15 Marks**

**1) Unit Test**

**2) Home Assignment**

**3) Project**

**4) Seminar**

**B. Sc. I**  
**Syllabus for Practical Chemistry DSC-1002A and DSC-1002B**

**Section I: Inorganic Chemistry**

- To prepare standard 0.1 N  $\text{KMnO}_4$  solution and to determine the strength of given oxalic acid solutions.
- To determine quantity of Fe ( II )ions from the given solutions by titrating it with 0.1 N  $\text{K}_2\text{Cr}_2\text{O}_7$  solutions by using internal indicator.
- Estimation of amount of Acetic acid from the given vinegar sample by titrimetric method.
- Water analysis: To determine the alkalinity of water sample by using Phenolphthaline and Methyl Orange Indicator
- To estimate amount of Cu (II) ions by iodometric titration by using  $\text{Na}_2\text{S}_2\text{O}_3$  solution
- **Spot Tests**  
Detection of following cations using spot tests:  $\text{Cu}^{2+}$ ,  $\text{Co}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Al}^{3+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Mg}^{+2}$ ,  $\text{Pb}^{2+}$
- **Paper Chromatography**  
Detection of following cations using Paper Chromatography:  $\text{Cu}^{2+} + \text{Co}^{2+}$ ,  $\text{Co}^{2+} + \text{Ni}^{2+}$ ,  $\text{Ni}^{2+} + \text{Cu}^{2+}$

**Section II: Organic Chemistry**

- Organic Spotting – (4)
- Estimation of Acetamide
- Estimation of Aniline
- Estimation of Aspirin from given pharmaceutical tablet.
- Bromination of phenol/aniline/acetanilide
- Benzoylation of amines/phenols
- Oximes and 2,4-DNPs of aldehydes/ketones



- Identify and separate the components of a given mixture of amino acids (Glycine, Aspartic acid, Glutamic acid. etc.) and sugars by Paper Chromatography.

### Section III: Physical Chemistry

- To study the reaction rate of hydrolysis of methyl acetate in presence of 0.5N HCl.
- To determine viscosity of given liquid A and B.
- Determination of enthalpy of ionization of acetic acid.
- Determination of enthalpy of neutralization of HCl with NaOH
- Determination of integral enthalpy of solution of salts (KNO<sub>3</sub>, NH<sub>4</sub>Cl).
- Determination of enthalpy of hydration of copper sulphate.
- Study of the solubility of benzoic acid in water and determination of  $\Delta H$ .
- Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps using pH-meter.
- To prepare and measure pH of buffer solutions (CH<sub>3</sub>COOH+CH<sub>3</sub>COONa) by potentiometer.
- To determine equivalent weight of Mg by Eudiometer.

### Reference Books

- 1) Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
- 2) Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
- 3) Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
- 4) Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
- 5) Khosla, B. D.; Garg, V. C. and Gulati, A. *Senior Practical Physical Chemistry*, S. Chand & Company, New Delhi, 2011.
- 6) Nadkarni, Kothari and Lavande *Practical Book of Physical Chemistry*
- 7) Findley A., *Experimental Physical Chemistry*
- 8) Das, R. C., B, Behra, *Experimens in Physical Chemistry*

- 9) Yadav J. B. *Advance Practical Physical Chemistry*
- 10) Clarke *Handbook of Organic Quantitative Analysis*
- 11) Ahluvalia V. K., *Comprehensive Practical Organic Chemistry*
- 12) Kulkarni, V. S., Dastane, R. *Laboratory Handbook of Organic Qualitative Analysis and Seperation*
- 13) Khopkar, S. M., *Basic Concepts in Analytical Chemistry*