

**UNIVERSITY OF PUNE**  
**REVISED SYLLABUS FOR S.Y. B.Sc. CHEMISTRY FROM 2009-2010**  
**(According to Semester system 2009-2010)**

**Course structure :** There will be four theory papers of 50 Marks each, (40 marks external + 10 marks internal) and one practical course of 100 marks. (80 marks External + 20 marks Internal) Two theory papers Physical Chemistry-CH-211 and Organic Chemistry-CH-212 will be taught in **SEMETER-I (First Term)** and the remaining two theory papers i.e. Inorganic Chemistry-CH-221 & Analytical Chemistry CH-222 will be taught in **SEMETER-II (Second Term)**. The examination will be held semesterwise for theory papers whereas the examination for practical course CH-223 will be held at the end of **SEMETER-II**

<b>SEMESTER</b>	<b>PAPER</b>	<b>COURSE TITLE</b>	<b>MARKS</b>
<b>I</b>	<b>CH-211</b>	<b>PHYSICAL CHEMISTRY</b>	<b>50</b>
<b>I</b>	<b>CH-212</b>	<b>ORGANIC CHEMISTRY</b>	<b>50</b>
<b>II</b>	<b>CH-221</b>	<b>INORGANIC CHEMISTRY</b>	<b>50</b>
<b>II</b>	<b>CH-222</b>	<b>ANALYTICAL CHEMISTRY</b>	<b>50</b>

**Practical Course in Chemistry CH-223 -**

**100 Marks**

**Prof. L. M. Hangarge**  
**Chairman,**  
**B.O.S., Chemistry**

**UNIVERSITY OF PUNE**  
**S.Y.B.Sc. Chemistry syllabus**  
**Physical chemistry CH- 211**

Sr. No.	Topics	Lecturers
1	Thermodynamics	08
2	Free Energy and Equilibrium	16
3	Colligative Properties of Solutions	12
4	Solutions of liquids in liquids	09
5	Distribution law	03
	<b>Total</b>	<b>48</b>

**1. Thermodynamics (08)**

Recapitulation of entropy, Thermodynamics of mixing, Entropy change or mixing of ideal gases, Third law of thermodynamics, Statement, Limitation, Importance of third law, evaluation of absolute entropies, use of absolute entropies.

Ref. 1 Relevant pages

Ref. 2 Relevant pages

Ref. 3 Relevant pages

**2. Free energy and equilibrium (16)**

Introduction, Helmholtz free energy, variation of Helmholtz free energy with volume and temperature, Helmholtz free energy change for chemical reaction, Gibb's free energy, Variation of Gibb's free energy with pressure and temperature, Gibb's free energy change for chemical reaction. Gibb's – Helmholtz equation, properties and significance of Gibb's free energy change, free energy change for ideal gas, Standard free energy change, Vant Hoff's reaction isotherm. The thermodynamic equilibrium constant, Relation between  $K_p$  and  $K_c$  for gaseous reactions, Variation of equilibrium constant with temperature, Criteria of chemical equilibrium, physical equilibria, Clapeyron equation and Clausius – Clapeyron equation, Applications of Clapeyron and Clausius – Clapeyron equation, numericals. Le chatelier – Braun principle, Application of Le chatelier – Braun principle to the formation of ammonia and phosgene.

Ref. 1 Page no. 189 to 200, 206 to 219

Ref. 2 Relevant pages

**3. Colligative properties of solutions (12)**

Introduction, Solution, electrolytes and nonelectrolytes, Meaning of term colligative property, lowering of vapour pressure of solvent in solution, elevation of B.P. of solvent in solution, Landberger's method, freezing point depression, Beckmann's method, Osmosis and Osmotic pressure, Berkeley and Hertley method, Modern osmometer, application of colligative properties to determine molecular weight of nonelectrolyte, abnormal molecular weight, Relation between Vant Hoff's factor and degree of dissociation of electrolyte by colligative property, Numericals.

**4. Solutions of liquids in liquids (9)**

Types of solution, Ideal solution, Raoult's law, Ideal dilute solution, Henry's law, Application of Henry's law, Vapour pressure – composition diagram of ideal and non ideal solution, Temperature – composition diagram of miscible binary solution, Distillation from temperature – composition diagram, Azeotropes, partially miscible liquid, immiscible liquids, distillation immiscible liquids, determination of molecular weight by steam distillation, numericals.

**Ref. 1** Page no. 261 to 264, 272 to 292, 294 to 296

**Ref. 2** Relevant pages

**Ref. 3** Relevant pages

**5. Distribution Law (3)**

Nernst distribution law, Statement and thermodynamic proof for Nernst distribution law, association and dissociation of solute in solvent, application of distribution law, numericals.

**Ref. 1** Page no. 298 to 302

**Reference books:**

1. Principles of Physical Chemistry by S. H. Maron and C. Prutton 4<sup>th</sup> edition
2. Physical Chemistry by W. J. Moore 5<sup>th</sup> edition
3. Physical Chemistry by P. W. Atkins 4<sup>th</sup> edition
4. Physical Chemistry by D. Alberty

**S.Y. B.Sc. Physical Chemistry Practical (Any Five)**

1. To determine the critical solution temperature of phenol – water system
2. To determine molecular weight of given organic liquid by steam distillation.
3. To determine molecular weight of given electrolyte (KCl) and non electrolyte (Urea) by Landberger's method and to study abnormal molecular weight of electrolyte.
4. To determine the degree of dissociation of potassium chloride by Landberger's method.
5. To determine molecular weight of solute by depression in freezing point method.  
A. Naphthalene – Sulphur      B. Naphthalene – acetanilide  
C. Naphthalene – m-dinitrobenzene.
6. To study association of benzoic acid in benzene by Beckmans method (Freezing point depression)
7. To determine the distribution coefficient of iodine between water and carbon tetrachloride and hence to determine the molecular condition of iodine in both solvent.
8. Determination of solubility of benzoic acid at different temperature and to determine  $\Delta H$  of dissolution process.
9. To study neutralization of acid (HCl) by base (NaOH) &  $\text{CH}_3\text{COOH}$  by NaOH and  $\text{H}_2\text{SO}_4$  by NaOH.

**References:**

1. Systematic experiment physical chemistry by Rajbhoj and Chondekar, Anjali publication
  2. Experiment in Physical Chemistry by R. C. Das and Behere Tata Mc. Graw Hill
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**UNIVERSITY OF PUNE**  
**S. Y. B.Sc. Chemistry Syllabus**  
**Semester I –(First Term)**  
**Paper CH – 212 Organic Chemistry**

Sr. No.	Topics	Lectures
1	Stereoisomerism (Three dimensional aspects of $sp^3$ hybridised carbon atom)	08
2	Chemistry of Aldehydes and Ketones	06
3	Chemistry of Natural and Unnatural carboxylic acids and their derivatives	04
4	Aliphatic and Aromatic amines	04
5	Functional group inter conversion C-C and C-hetero atom bonds	07
6	Chemistry of homocyclic and heterocyclic compounds with one hetero atom	04
7	Introduction to Biomolecules	15
<b>TOTAL</b>		<b>48</b>

**1. Stereoisomerism : (Three dimensional aspects of  $sp^3$  hybridised carbon) (08)**

- i. Introduction – optical isomerism, chirality and optical activity. Three dimensional representation of chiral centre, enantiomers, Absolute configuration, R/S system and D/L Nomenclature.
- ii. Optical isomer with two chiral centers (AA and AB type) Erythro, threo, meso, diastereomers.
- iii. Stereoisomerism in cycloalkanes- Baeyer's strain theory, Heats of combustion and relative stability of cycloalkanes, factors affecting the stability of conformation, conformations of cyclohexane, Equatorial and axial bonds in cyclohexane. Monosubstituted cyclohexanes. Stability of – Cl, Br, I, –OH, –CH<sub>3</sub>, –C(CH<sub>3</sub>)<sub>3</sub> substituted cyclohexanes.

**Ref. 1** section: 4.17 to 4.19, 13.8, 13.10 to 13.12, **Ref. 3** relevant pages.

**Pages** : 144 to 147, 450, 451, 453 to 463.

**2. Chemistry of Aldehydes and Ketones (06)**

a) Structure of carbonyl groups. b) Nomenclature of Aldehyde and ketones c) Physical properties of aldehydes and ketones d) Preparations of aldehydes from primary alcohol, methyl benzenes, acid chlorides, phenols e) Preparation of ketones from – secondary alcohols, Friedel Craft acylation, nitriles f) Reaction of aldehydes and ketones – (i) Oxidation (ii) reduction – catalytic reduction, metal hydrides – LiAlH<sub>4</sub>, NaBH<sub>4</sub>. Clemmenson's reduction, Wolf kishner, Thioketal reduction, (iii) Addition of cyanides (iv) Addition of derivatives of ammonia (v) Addition of alcohols (vi) Cannizzaro reaction (vii) Addition or Grignard reagent (viii) Aldol condensation (ix) Perkins reaction (x) haloform reactions g) Analysis of aldehyde and ketones.

**Ref. 1** Section – 18.1 to 18.5, 18.7 to 18.16, 18.20, 18.21

**Pages** : 657 to 667, 669 to 692, 697

**3. Chemistry of Natural and Unnatural carboxylic acids and their derivatives (04)**

a) Introduction – Natural and unnatural carboxylic acid with example b) Structure of simple carboxylic acid c) Classification d) Nomenclature e) Physical properties f) preparation of carboxylic acid from – primary alcohol, oxidation of alkyl benzenes, carboxylation of Grignard reagent, hydrolysis of nitriles, Kolbe's reaction g) Reaction of carboxylic acids, acidity, salt

formation, conversion into acid chlorides, esters, amides, acid anhydrides h) Hell-Volhard Zelinsky reaction (halogenation of aliphatic acids). i) Analysis of carboxylic acids j) Acid derivatives – structure nomenclature, preparations, properties of acid chloride, amides, ester and acid anhydrides.

**Ref. 1** section : 19.1, 19.3, 19.6 to 19.9, 19.21, 20.1 to 20.3, 20.6, 20.7, 20.9, 20.13, 20.15, 20.16  
**Pages** : 713-717, 720-728, 744, 753, 755, 763-768, 773.

#### **4. Aliphatic and Aromatic amines (04)**

a) Structure b) Classification c) nomenclature d) physical Properties – salt of amine  
 e) preparation of amine from – reduction of nitro compounds, reductive amination, reduction of nitriles, Hoffmann degradation of amides f) Reactions of amines - basicity, salt formation, alkylation, conversion into amides, ring substitution in aromatic amines, Hoffmann elimination, reactions with nitrous acid g) Diazonium salts – preparation and reactions h) Sandmeyer reaction i) Replacement of nuclear 'H' by – I, –OH and H<sup>+</sup> j) Analysis of amines.

**Ref. 1** section : 22.1 to 22.5, 22.8, 23.1, 23.2, 23.12, 23.19

**Pages** : 821–825, 828–830, 845–850, 866–868, 876

#### **5. Functional Group Inter conversion C-C and C-heteroatom bonds (07)**

Based upon the knowledge of the functional group chemistry studied at F. Y. B. Sc. and S. Y. B. Sc. level the student should be able to suggest – How to bring about the given organic conversions? The conversion should include -

- Functional groups inter conversion (FGI) - involving C-C and C-heteroatom bonds.
- Converting the given molecule into another molecule with more or less number of carbon atoms  
 (Step up and step down reactions)
- Suggesting synthetic routes to the given target molecules.
- Suggesting the set of reagents to bring about the conversion.
- Predict the products if the reactant and conditions are given, including the major and minor products.

**Ref. 1** : Relevant pages

#### **6. Chemistry of Homocyclic and Heterocyclic compounds (04)**

- Naphthalene and Anthracene. Numbering of carbon atoms, nomenclature of derivatives, preparation and reactions of naphthalene and anthracene.
- Heterocyclic compounds – Definition, classification, nomenclature of heterocyclic compounds.
- Five membered heterocyclic compounds - furan, pyrrole, Thiophene, nomenclature, preparation of 1, 4-diketones, reactions sulphonation, F. C. Acylation, Diazocoupling, Riemeier – Tiemann reaction, catalytic hydrogenations.
- Six membered heterocyclic compounds, Pyridine, structure, preparation from picoline, acetylene, acrolein, reactions nitration, sulphonation, bromination, catalytic hydrogenation.

**Ref. 1** : Relevant pages.

## 7. Introduction to Biomolecules. (15)

**a) Introduction :** What are different Biomolecules found in and associated with living system? How is biochemistry directly concern to life i.e. what is the scope and impact of biochemistry on living system? Importance of biochemistry. **Ref. 2** Relevant pages.

**b) Carbohydrates :** Definition, classification, reactions of carbohydrates – oxidation, reduction osazone formation, ester formation, isomerization, Killiani Fischer synthesis, Ruff degradation, D/L configuration, configuration of D(+) Glucose, Fischer proof and mutarotation, cyclic structure of glucose-Fischer Haworth and chair configuration. Brief account of maltose, sucrose, lactose, cellobiose, polysaccharides - starch, cellobiose

**Ref. 1** section : 34.2–34.4, 34.6–34.9, 34.11, 34.16, 35.1 to 35.9

**Pages :** 1185 – 1195, 1200

**c) Amino acids, proteins, enzymes :**

**i)  $\alpha$ -amino acids :** Fischer projection, relative configuration, classification, structure of amino acid, properties and reactions of  $\alpha$ -amino acids.

**ii) Proteins :** Formation of peptide linkage, feature of peptide linkage,  $\alpha$ -helical conformation,  $\beta$ -plated structure, primary, secondary, tertiary and quaternary structure of proteins.

**iii) Enzymes :** General information, co-enzymes, and vitamins hormones, prosthetic groups and their role, enzymes specificity, classification of enzymes with examples.

**d) Nucleic acids :** Structure of RNA and DNA

**e) Lipids :** General introduction, classification with examples.

**Ref. 2** Relevant pages

**Reference Books :**

Ref. 1 : Organic Chemistry - 6h Ed. Morrison and Boyd Prentice Hall of India Pvt Ltd, New Delhi - 2001.

Ref. 2 : Outline of Biochemistry 5h Ed., Conn, Sumpf, Bruening and Roy Doi John wiley 1987.

Ref. 3 : Stereochemistry by Eliel

### Aims and Objectives

Students should be able to –

**Chapter 1 : Stereoisomerism : (Three dimensional aspects of  $sp^3$  hybridised carbon)**

- i) Identify chiral center in the given organic compounds.
- ii) Define Erythro, threo, meso, diastereoisomers with suitable examples.
- iii) Able to find R/S configuration in compounds containing two chiral centers.
- iv) Explain Bayer's strain theory, Heat of combustion and relates stability of cycloalkanes.
- v) Explain the stability of cyclohexanes.
- vi) Draw the structure of boat and chair configuration of cyclohexane.
- vii) Draw axial and equatorial bonds in cyclohexane.
- viii) Draw structure of conformations of mono-substituted cyclohexanes.
- ix) Explain the stability of axial and equatorial conformation of Monosubstituted cyclohexanes.

**Chapter 2 : Chemistry of Aldehyde and ketones.**

- i) Draw structure of carbonyl compounds and differentiate between aldehyde and ketones.
- ii) Explain the properties of aldehyde and ketones.
- iii) Prepare aldehyde from primary alcohols, methyl, benzene, acid chlorides and phenols.
- iv) Prepare ketones from secondary alcohols, nitriles, Friedel Craft acylation.
- v) To write and complete various reactions of aldehyde and ketones.
- vi) Distinguish between aldehydes and ketones.

**Chapter 3 : Chemistry of Natural and Unnatural carboxylic acids and their derivatives**

- i) Natural and unnatural carboxylic acid
- ii) Write functional group of acid and their derivatives
- iii) Explain physical and chemical properties of carboxylic acid
- iv) To write and complete various reactions of carboxylic acids
- v) Write structure, nomenclature, preparations and explain properties of acid chloride, amides and acid anhydrides.

**Chapter 4 : Aliphatic and Aromatic amines**

- i) Classification and name of amines.
- ii) Explain physical properties of amine and their derivative.
- iii) To write and complete various reactions of amines.
- iv) To explain methods of preparation of amines.
- v) Distinguish between 1<sup>o</sup>, 2<sup>o</sup>, 3<sup>o</sup> amines.

**Chapter 5 : Functional group Inter conversion**

- i) Know different function groups
- ii) Know step up and step down reactions
- iii) Specific reagent for specific conversion
- iv) Able to suggest synthetic route for given target molecule
- v) Predict major and minor product in the given reaction if possible

**Chapter 6 : Chemistry of Homocyclic and Heterocyclic compounds**

- i) Define and classify heterocyclic compounds.
- ii) Use Huckel rule to predict aromaticity.
- iii) Suggest synthetic route for preparation of various heterocyclic compounds.
- iv) Write and complete various reactions of heterocyclic compounds.
- v) Predict products.
- vi) Suggest synthetic route for preparation of naphthalene and anthracene.

**Chapter 7 : Introduction to Biomolecules**

- i) Know different biomolecules.
- ii) Appreciate the role of biochemistry in the day to day life.
- iii) Understand the importance of biochemistry.
- iv) Define carbohydrates.
- v) Classify carbohydrates giving suitable examples.
- vi) Write and complete various reactions of glucose.
- vii) Explain optical activity in carbohydrates.
- viii) Write Fischer projection and perspective formula with glyceraldehydes as reference compound.
- ix) Explain the principle in Killani Fischer synthesis.
- x) Explain stereoisomerism in monosaccharide.
- xi) Draw structure of some common aldoses and ketoses.
- xii) Distinguish between diastereomers and epimers.
- xiii) Write cyclic structure of glucose in Fischer, Haworth and chair form.
- xiv) Know the phenomenon of mutarotation.
- xv) Draw the structure and bonding in maltose, lactose, cellobiose and sucrose.
- xvi) Know about polysaccharide, structures of starch and cellulose.



- xvii) Classify the naturally occurring amino acids.
- xviii) Explains the amphoteric nature of amino acids.
- xix) Know the important reactions of  $\alpha$ -amino acids.
- xx) Outline the formation of peptide bond.
- xxi) Explain the hydrogen bonding in  $\alpha$ -helical structure.
- xxii) Relate the stability of  $\alpha$ -helical chain and their R-groups.
- xxiii) Define primary, secondary, tertiary and quaternary structure of proteins.
- xxiv) Classify proteins.
- xxv) Classify enzymes.
- xxvi) Know prosthetic groups and their role.
- xxvii) Classify lipids
- xxviii) Structure of DNA and RNA

### **S. Y. B. Sc. Organic Chemistry Practicals ( 5 Practicals)**

#### **1) Organic Qualitative Analysis** (6 compounds, two compounds per day)

Identification of organic compounds through –

- a) Type determination of organic compound b) preliminary tests c) detection of elements (Sodium fusion tests) d) Detection of functional groups e) melting point / Boiling point
- i) Acids (Any two) : benzoic, salicylic, phthalic, cinnamic, oxalic and salicylic acid
- ii) Phenols (Any two) :  $\alpha$ -naphthol,  $\beta$ -naphthol, resorcinol, o-nitrophenol, p-nitrophenol
- iii) Base (Any two) : Aniline, p-toluidine, diphenylamine, N, N-dimethylaniline, o-nitroaniline  
m-nitroaniline, p-nitroaniline
- iv) Neutral (Any two) : Benzaldehyde, glucose, fructose, acetone, ethylmethyl ketone, acetophenone, methyl acetate, ethyl acetate, naphthalene, Anthracene, Nitrobenzene, m-dinitrobenzene, Acetamide, Urea, Acetanilide, Chloroform, Carbon tetrachloride, Thiourea.

#### **2) Organic Preparation (Any two)**

(With crystallisation, m. p. and TLC)

- 3) Aspirin from salicylic acid
- ii) Benzoic acid from toluene
- iii) Phthalimide from phthalic anhydride
- iv) Osazone form glucose and mannose

#### **3) Purification of organic liquids by distillation (any two mixtures) one volatile and one non volatile**

**Ref. 1** Organic Qualitative Analysis – A. I. Vogel

#### **Aims and Objectives**

After completion of practical course student should be able to –

- i) Verify theoretical principles experimentally.
- ii) Acquire skill of crystallisation, record correct m. p. / b. p.
- iii) Perform the complete chemical analysis of the given organic compound and should be able to recognize the type of compound.
- iv) Write balanced equation for all the reactions, they carry in the laboratory.
- v) Perform the given organic preparation according to the given procedure.
- vi) Follow the progress of the reaction by using TLC technique.
- vii) Set up the apparatus properly for the given experiments.
- viii) Perform all the activities in the laboratory with neatness and cleanness.

**UNIVERSITY OF PUNE**  
**S.Y.B.Sc. Chemistry Syllabus**  
**Semester II: (Second Term)**  
**Paper CH : 221- Inorganic Chemistry**

Sr. No.	Topics	Lectures
1.	General Principles of Metallurgy	05
2.	Metallurgy of Aluminium (Electrometallurgy)	04
3.	Metallurgy of Iron and Steel (Pyrometallurgy)	06
4.	Chemistry of p-block Elements (III A to VII A groups)	06
5.	Chemistry of d-block Elements	07
6.	Chemical toxicology	05
7.	Acids, bases, solvents and reactions in non-aqueous solvents	08
8.	Corrosion and passivity	07
	TOTAL	48

**(1) General Principles of Metallurgy: (5)**

Introduction occurrence of metals, ores and minerals, types of ores, operations involved in metallurgy, crushing, comminution, various methods of concentration such as hand picking, gravity separation, magnetic separation. Froth flotation, Calcinations, Roasting etc. Reduction, various methods of reduction such as smelting, Aluminothermic process and electrolytic reduction, Refining of metals, various methods of refining such as poling, liquation, electrolytic and vapour phase refining.

**References :**

- i) Advanced Inorganic chemistry, Satyaprakash, Tuli, Basu, pages 262-271.
- ii) Text book of Inorganic chemistry, P.L. Soni, pages 2.3-2.8, 2.13-2.17.

**(2) Metallurgy of Aluminium (Electrometallurgy) : (4)**

Occurrence, physiochemical principles, Extraction of Aluminium, Purification of bauxite by Bayer's process, Electrolysis of alumina, application of aluminum and its alloys.

**References :**

- i) Advanced Inorganic chemistry, Satyaprakash, Tuli, Basu pages 458-463.
- ii) Text book of Inorganic chemistry, P.L. Soni pages 2.209 to 2.211.

**(3) Metallurgy of Iron and Steel (Pyrometallurgy) (6)**

Occurrence, concentration, calcination, smelting physio-chemical principles, reactions in the blast furnace, wrought iron, manufacture of steel by Bessemer and L.D. process, its composition and applications.

**References :**

- i) Advanced Inorganic chemistry, Satyaprakash, Tuli, Basu pages 830-849.

**(4) Chemistry of p-block Elements (III A to VII A groups) (6)**

Position of elements in the periodic table, electronic configuration of elements, Reasoning of anomalous behaviour of first member of each group. Trends in the properties of the elements with respect to following points - size of atoms and ions, ionisation potential, electron negativity, oxidation state, reactivity.

Bonding and shapes of following molecules –  $B_2H_6$ ,  $PCl_5$ ,  $Al_2Br_6$ ,  $CO_2$ ,  $SF_6$ ,  $H_2SO_4$ , Allotropes of carbon diamond, graphite and fullerene.

**References:** Concise, Inorganic chemistry by J.D. Lee, relevant pages.

**(5) Chemistry of d-block elements (7)**

Position of d-block in periodic table, trends in properties of these elements w.r.t.

(a) size of atoms & ions (b) reactivity (c) catalytic activity (d) oxidation state (e) complex formation ability (f) colour (g) magnetic properties (h) non-stoichiometry (i) density, melting & boiling points.

**Reference:** 1. Concise Inorganic Chemistry by J. D. Lee-relevant pages.

2. General Chemistry-Raymond Chang- relevant pages.

**(6) Chemical Toxicology (5)**

- i) Toxic chemicals in the environment.
- ii) Impact of toxic chemistry on enzymes.
- iii) Biochemical effect of Arsenic.
- iv) Biochemical effect of cadmium.
- v) Biochemical effect of Lead.
- vi) Biochemical effect of Mercury.
- vii) Biological methylation.

**Reference :**

- i) Fundamental chemistry A. K. Dee. (3<sup>rd</sup>Ed)

**(7) Acids Bases, Solvents and Reactions in non-aqueous solvents : (8)**

Definition of acids and bases, Arrhenius theory, Lowry bronsted theory (in brief), Lewis concept, Lux-flood theory, strength of acids and bases. Trends in strength of hydracids and oxacids, properties of solvents - M. P., B. P. dipole-moments, dielectric constant, Lewis acid-base character, protonic acidity, Types of solvents. Hard & soft acids and bases

**Reference :**

- i) Basic Inorganic chemistry by F. A. Cotton, pages 163-173. and relevant pages.
- ii) Concepts and models of Inorganic chemistry by Dongles and Mc. Daniels, pages 183-193. and relevant pages.

**(8) Corrosion and Passivity: (7)**

**(a) Corrosion :** Definition of corrosion, Types of corrosion, Atmospheric, Immersed, Mechanism of electrochemical corrosion, Factors affecting corrosion - position of metal in E. C. S., purity effect of moisture, effect of oxygen, pH, physical state of metal, alloy formation, making metal cathodic, controlling external condition. Coating - galvanising, Tinning, electroplating, metal cladding, organic coating.

**(b) Passivity :** Definition, Theories of passivity - (i) oxide film theory (ii) Gaseous film theory (iii) Physical film theory, valence theory, catalytic theory, Allotropic theory, electrochemical passivity.

**Reference :**

- i) Introduction to electrochemistry by S. Glasstone 2<sup>nd</sup> Ed. pages 491-503.

## Aims and Objectives

### (1) Principles of Metallurgy :

**Aims :** To study principles and process of metallurgy.

**Objectives :** A student should be able -

- i) To differentiate between ore and minerals.
- ii) To differentiate between calcination and roasting and smelting.
- iii) To know the different methods for separation of gangue or matrix from metallic compounds.
- iv) To know the terms smelting, flux.

### (2) Metallurgy of Aluminium (Electrometallurgy)

**Aims :** To study metallurgy of Aluminium.

**Objectives :** A student should be able -

- i) To know physico-chemical principles involved in electrometallurgy.
- ii) To understand electrolysis of alumina and its refining.
- iii) To explain the uses of Aluminum and its alloys.
- iv) To know purification of bauxite ore.

### (3) Metallurgy of Iron and steel (Pyrometallurgy) :

**Aims :** To study metallurgy of Iron.

**Objectives :** A student should be able -

- i) To explain the term pyrometallurgy and to explain the physico chemical principles involved in the reduction process by carbon monoxide.
- ii) To know different reactions in the blast furnace.
- iii) To differentiate between properties of pig iron and wrought iron.
- iv) To explain the basic principles of different methods for preparation of steel.
- v) To explain the merits and demerits of different methods.

### (4) Chemistry of p-block elements (III A to VIII A groups) (6)

A student should be able -

- i) To write electronic configuration of any element.
- ii) To give reasons for anomalous behavior of first element of IIIA to VII A groups with other elements in the same group.
- iii) To know the exact position p-block elements in the long form of the periodic table.
- iv) To know the bonding and shapes of following molecules -  $\text{Al}_2\text{Br}_6$ ,  $\text{CO}_2$ ,  $\text{SF}_6$ ,  $\text{H}_2\text{SO}_4$ .
- v) To know the allotropes of carbon.

### (5) Chemistry of d-block Elements

- i) To know position of d-block elements in periodic table.
- ii) To know the general electronic configuration & electronic configuration of elements.
- iii) To know trends in periodic properties of these elements w.r.t. size of atom and ions, reactivity, catalytic activity, oxidation state, complex formation ability, colour, magnetic properties, non-stoichiometry, density, melting point, boiling point.

### (6) Chemical Toxicology :

A student should be able -

- i) To know toxic chemical in the environment.
- ii) To know the impact of toxic chemicals on enzyme.
- iii) To know the biochemical effect of Arsenic, Cd, Pb, Hg.
- iv) To explain biological methylation.

**(7) Acids, Bases, Solvents and reactions in non-aqueous solvents :**

**Aims :** To study different solvents and to know the different theories of acids and bases.

**Objectives :** A student should be able -

- i) To define acids and bases according to Arrhenius theory Lowery- Bronsted concept, Lewis concept.
- ii) To explain the merits and demerits of different theories of acids and bases.
- iii) To define the conjugate acid and base pairs.
- iv) To explain the leveling effect of solvents.
- v) To give the trends in the strength of hydracids oxyacids.
- vi) To define hard and soft acids.
- vii) To know the trends in the strength of hydra and oxyacids.
- viii) To know the rules governing the strength of oxyacids.
- ix) To explain the properties of a solvent that determines their utility.
- x) To know some useful solvents.
- xi) To explain the reactions in non-aqueous solvents like HF and NH<sub>3</sub>.

**(8) Corrosion and Passivity :**

A student should know -

- i) Definition of corrosion.
- ii) Types of corrosion.
- iii) Mechanism of corrosion.
- iv) Factors affecting corrosion.
- v) Methods of prevention of metal from corrosion.
- vi) Meaning of passivity.
- vii) Different theories of passivity.
- viii) Galvanising, Tinning, Electroplating from corrosion.

**S. Y. B. Sc. Inorganic Chemistry Practicals**

Inorganic Qualitative Analysis of Binary Mixtures (including phosphates and borates). Sodium carbonate extract is to be used wherever necessary for detecting acidic radicals. (Minimum five Mixtures)

**Ref.** Inorganic Qualitative Analysis by Vogel

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**UNIVERSITY OF PUNE**  
**S. Y. B. Sc. Chemistry Syllabus**  
**Semester II (Second Term)**  
**Chemistry Paper CH-222**  
**Analytical Chemistry**

Sr. No.	Topics	Lectures
1	Introduction to Analytical chemistry	03
2	Inorganic Qualitative Analysis	07
3	Analysis of organic compounds	08
4	Errors in Quantitative Analysis	05
5	Volumetric Analysis a. Acid- base b. Oxidation-Reduction c. Complexometric d. Indrometry, Iodimetry e. Argentimetry	18
6	Solvent Extraction	07
		48

**(1) Introduction to Analytical chemistry (03)**

Importance, the analytical process, sampling (solid liquid and gases), Hazards in sampling, sample treatment (aqueous acid, fluxes, ashing)

**Ref. 1** pages 1.7, **Ref 2** pages 764-772

**(2) Inorganic Qualitative Analysis (07)**

Basic principles, common ion effect, solubility, solubility product, preparation of original solution, classification of basic radicals in groups, separation of basic radicals. Removal of interfering anions (phosphate and borate) Detection of acidic radicals.

**Ref. 3** pages 503-534, 568-570

**(3) Analysis of Organic Compounds (Qualitative & Quantitative) (08)**

- a) Types of organic compounds. Characters tests and reactions of different functional groups.
- b) Analysis - Estimation of C, H(O) by combustion tube, Detection of nitrogen, sulphur, halogen and phosphorus by Lassaigen's test.
- c) Estimation of nitrogen by Duma's Kjeldahl's method. Estimation of Halogen, Sulphur and phosphorus by Carious method.
- d) Determination of empirical and molecular formula, Numerical problems.

**Ref. 5** pages 933-940 and relevant pages.

**(4) Errors in Qualitative Analysis****(05)**

Accuracy and precision, methods of expressing accuracy, methods of expressing precision, classification of errors, minimization of errors, significant figures and computations, Numerical problems.

**Ref 4** pages 127-135.

**(5) Volumetric Analysis****(18)**

Introduction to volumetric analysis, calibration of apparatus (burette, pipette and volumetric flask) standard solution and their preparation. Various methods of expressing the concentration of solutions. Equivalent weight in different types of reactions, primary and secondary standard solutions, Numerical problems.

**Classification of volumetric analysis**

**5. a) Acid base (neutralisation) titrations :** Theory of indicators, theory of acid base indicators, mixed and universal indicators, neutralisation curves for strong acid - strong base, weak acid - strong base, weak base - strong acid, weak acid - weak base, polybasic acid with strong base. Displacement titrations, choice of indicators, numerical problems.

**5. b) Oxidation-Reduction Titration :**

Principle, titration curves with reference to Fe (II) and Ce(IV) reactions , detection of end points, Numerical problems.

**Ref. 4** relevant pages

**5. c) Complexometric Titration:-** Principal, Mg- EDTA complex, Standardisation,

**5 d) Iodometry and Iodimetry**

General discussion, detection of end point, difference between idometry and iodimetry. Standardisation of sodium thiosulphate solution with potassium dichromate and iodine method.

**Applications** – Estimation of copper in crystalline copper sulphate, Estimation of available chlorine in bleaching powder.

**Ref. 6** pages 370-382.

**5 e) Argentimetry**

Standardisation of silver nitrate solution by Mohr's method and by Fujan's method, determination of chloride, bromide and iodide individually and in a mixture.

**Ref. 6** pages 338-340

**(6) Solvent Extraction :-****(07)**

Introduction, Principle of solvent extraction, Distribution coefficient, distribution retio, relation between Distribution coefficient and distribution retio, factors affecting solvent extraction, percentage extracted, solvent exraction method, sepration factor, batch extraction, counter current extraction, application of solvent extraction, numerical problems.

**References: 7,9,10,11** Relevant pages.

### Reference Books

- 1) Analytical chemistry by G. D. Christain, John Weiley and sons, 5<sup>th</sup> Edition.
- 2) Fundamentals of Analytical chemistry by D. A. Skoog, D. M. West and F. J. Holler, 6<sup>th</sup> Edn.
- 3) A text book of macro and semi micro Qualitative analysis by A. I. Vogel, 5<sup>th</sup> Edition
- 4) Vogel's text book of Quantitative Inorganic Analysis revised Edn. J. Barret, R. C. Danney, G.H. Jeffery and J. Mendham ELBS.
- 5) Quantitative organic Analysis 4<sup>th</sup> Ed. A. I. Vogel ELBS
- 6) Quantitative Inorganic Analysis 4<sup>th</sup> Ed A. I. Vogel ELBS
- 7) Instrumental methods of chemical Analysis by Chatwal and Anand 6<sup>th</sup> Edition
- 8) A text book of Quantitative Inorganic Analysis A. I. Vogel 3<sup>rd</sup> Edition.
- 9) Basic concept of analytical chemistry- S. M. Khopkar.
- 10) Instrumental methods of chemical analysis-Willard, Deen & Merrit-6<sup>th</sup> Edition.
- 11) Analytical chemistry by Skoog.

### Aims and Objectives

#### 1) Introduction to Analytical Chemistry

A student should know -

- i) Importance of Analytical chemistry
- ii) Different process in analysis
- iii) Sampling of solids
- iv) Sampling homogenous and heterogenous liquids, gases samples.
- v) Hazards in sampling
- vi) Introduction to sample treatment using aqueous, dilute acids, strong acids, fluxes and ashing.

#### 2) Inorganic Qualitative Analysis

A student should know -

- i) Basic principles in qualitative analysis.
- ii) Meaning of common ion effect.
- iii) Role of common ion effect and solubility product.
- iv) How to find proper solvent for preparation of solution.
- v) Group reagent and precipitating agent.
- vi) Different groups for basic radical.
- vii) How to remove interfering ions.
- viii) Separation for basic radicals.
- ix) Role of  $\text{NH}_4\text{Cl}$ ,  $\text{NaOH}$ , yellow ammonium sulphide and able to find acidic radicals.

#### 3) Analysis of organic compounds

A student should know –

- i) Different test for detection of elements like C, H, (O), N, S, phosphorus.
- ii) Quantitative analysis of C, H by Liebig's method.
- iii) Principle of Kjeldhal's method with example.
- iv) Principle of Carius tube method.
- v) empirical and molecular formula.
- vi) solve numerical problems.
- vii) Different type of organic compounds
- viii) Characteristic tests for different functional groups
- ix) Different colour tests and the reactions



#### 4) Errors in Quantitative Analysis

A student should know –

- i) Definitions and difference in accuracy and precision.
- ii) Absolute and relative error.
- iii) Different terms such as mean deviation, standard deviation, relative standard deviation.
- iv) Instrumental errors, personal errors
- v) Solve the numerical problems.

#### 5) Volumetric Analysis

A student should be able to

- i) Calibrate various apparatus such as burette, pipette, volumetric flask, barrel pipette etc.
- ii) Meaning of equivalent weight, molecular weight, normality, molality, primary and secondary standards.
- iii) Different way to express concentrations of the solution.
- iv) To prepare a standard solution.
- v) To solve numerical problems.
- vi) To classify different reactions in volumetric analysis.
- vii) Explain role of indicators.
- viii) Know mixed and universal indicators.
- ix) Know neutralisation curves for various acid base reactions.
- x) Know principle of complexometric precipitation and redox reactions with one example.
- xi) Know the definitions and difference between iodometry and iodimetry.
- xii) To prepare standard sodium thiosulphate solution.
- xiii) Reactions between  $\text{CuSO}_4$  and Iodine and liberated  $\text{I}_2$  and  $\text{Na}_2\text{S}_2\text{O}_3$
- xiv) Use of indicator.
- xv) Estimate copper from  $\text{CuSO}_4$  and available chlorine in bleaching powder.
- xvi) Prepare standard silver nitrate solution.
- xvii) Mohr's and Fajan's method.
- xviii) Determine the amount of halides separately and in presence of each other.
- xix) Use specific indicator for titration.

#### 6) Solvent Extraction

A student should know-

- i) Principles of solvent extraction.
- ii) Difference between KD and D
- iii) Various types of techniques of solvent extraction such as-(a) extraction (b) continuous extraction  
(c) counter current extraction.
- iv) Difference between batch and multiple extraction.
- v) Advantages and applications of solvent extraction.
- vi) To solve the numerical problems.

### Analytical Chemical Practicals (Any Five)

1. a) Preparation of standard 0.05 N oxalic acid solution and standardisation of approx. 0.05N  $\text{KMnO}_4$  solution.  
b) Determination of the strength of given  $\text{H}_2\text{O}_2$  solution with standard 0.05 N  $\text{KMnO}_4$  solution.
2. Estimation of Aspirin from a given tablet and find errors in quantitative analysis  
a) Find absolute and relative error with reference to the mean of the analysis  
b) Find standard deviation and relative standard deviation with reference to the mean of the analysis
3. a) A choice of best indicator for titrating between approx. 0.05 N NaOH and standard 0.05N oxalic acid solution and standardisation of NaOH by using best indicator.  
b) Determination of acetic acid in commercial vinegar by titrating with standard NaOH using selected best indicator.
4. Determination of the percentage available chlorine form bleaching powder
5. Determination of the percentage of dissolved oxygen by Winkler's method
6. Estimation of Al (III) from the given aluminium salt solution by using Erichrome Black-T indicator (Back titration method)
7. Estimation of copper iodometrically.
8. Estimation of  $\text{Fe}^{++}$  using external indicator.
9. Report on one day industrial educational visit.

**Note:-** All volumetric experiments should be performed by using two burette method.

**Ref. 1** Quantitative Inorganic Analysis by A. I. Vogel 4<sup>th</sup> Ed.

**Ref. 2** Qualitative Inorganic Analysis by A. I. Vogel 4<sup>th</sup> Ed.

### UNIVERSITY OF PUNE S.Y. B.Sc. CHEMISTRY PRACTICAL (Scheme of Marking)

Q. No.	Experiment	Marks
1	Physical / Analytical Experiment	35
2	Inorganic Qualitative Analysis OR a) Organic Qualitative Analysis b) Organic Preparation	35 20 15
3	Oral	10
	Total	80

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