RAJARSHI SHAHU MAHAVIDYALAYA, (AUTONOMOUS)

LATUR – 413512

DEPARTMENT OF CHEMISTRY

Syllabus

B.Sc. (Third Year) Chemistry
CBCS Pattern

(V & VI Semester)

With Effect from 2019-2020

Rajarshi shahu Mahavidyalaya, (Autonomous) Latur-413512

B.Sc. Third Year (Semester – V)

w.e.f. 2019-20

Paper	Course Code	Course Title	Periods Per Week	Total Periods	Marks	Credits
IX	U-CHE-557 DSEC	Physical and Inorganic Chemistry OR Physical and Inorganic Chemistry (elective)	03	30+15=45	50	02
X	U-CHE-558	Organic and Inorganic Chemistry	03	30+15=45	50	02
VII	U-CHE-559 DSEC-P	Laboratory Course – VII OR Laboratory Course –VII (elective)	03	45	50	01
VIII	U-CHE-560	Laboratory Course –VIII	03	45	50	01
-	(SECC-III)	Skill enhancement course-III (Theory+ Practical)	03 (1+2)	45	50 (20+30)	02*
			Total		**250**	**06(02*)=08**

B.Sc. Third Year (Semester – VI)

w.e.f. 2019-20

Paper	Course Code	Course Title	Periods Per Week	Total Periods	Marks	Credits
XI	U-CHE-657	Physical and Inorganic Chemistry	03	30+15=45	50	02
XII	U-CHE-658 DSEC	Organic and Inorganic Chemistry OR Organic and Inorganic Chemistry (DSEC)	03	30+15=45	50	02
IX	U-CHE-659	Laboratory Course – IX	03	45	50	01
X	U-CHE-660 DSEC-P	Laboratory Course –X OR Laboratory Course –IX (elective)	03	45	50	01
-	(SECC-IV)	Skill enhancement course-IV (Theory+ Practical)	03 (1+2)	45	50 (20+30)	02*
			Total		**250**	**06(02*)=08**

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Rajarshi Shahu Mahavidyalaya (Autonomous), Latur.

Faculty of Science

B.Sc. III Year (Semester - V)

Chemistry – I

Paper Code : U-CHE-557

(Physical Chemistry & Inorganic Chemistry)

Marks: 50 **Periods: 45**

Credit: 02 **Weeks: 06**

Learning Objective:

1. To learn the basic concepts like planks quantum theory, photoelectric effect.

2.To understand the concepts of surface chemistry, types of adsorption, Freundlic adsorption isotherm etc.

3.To introduce the students about Molecular Spectroscopy

4.To learn about role, applications of bio inorganic chemistry

5. To know about properties of d-block elements (First transition series)

Course Outcome:

After successful completion of the course the students will :

1. To learn about the planks quantum theory, Compton effect, Heisenberg's uncertainty principle.

2. To know the difference between different types of adsorption,and adsorption isotherm phenomenon.

3. To familiarize with principles of Molecular Spectroscopy and their applications.

4. To understand the functions of various biomolecules like hemoglobin, myoglobin etc.

5. To Familiarize with first transition series and their properties.

Section A (Physical Chemistry)

Unit - I Quantum Chemistry : 11 Periods

1.1. Introduction: Origin of quantum mechanics, limitations of classical mechanics.

1.2 Black body radiation, Stefan – Boltzmann law.

1.3 Planck's quantum theory of radiation.

1.4 Photoelectric effect, explanation on the basis of quantum theory.

1.5 Compton effect.

1.6 De-Broglie hypothesis – Derivation of de-Broglie equation, explanation.

1.7 Davisson – Germer experiment.

1.8 Heisenberg's uncertainty principle, (Statement, explanation)

1.9 Schrodinger wave equation: Derivation in time independent form. Laplacian operator form. Physical significance of Ψ and Ψ^2.

1.10 Postulates of quantum mechanics.

Unit II – Surface chemistry 05 Periods

2.1 Introduction – Adsorption, Mechanism of adsorption, factors affecting adsorption, difference between adsorption and absorption.

2.2 Types of adsorption – physical adsorption and chemical adsorption.

2.3 Adsorption of gases by solids.

2.4 Adsorption isotherm: Freundlich adsorption isotherm and Langmuir adsorption isotherm.

Unit III – Molecular Spectroscopy 14 Periods

3.1 Introduction – Electromagnetic radiation and its characteristics, Electromagnetic spectrum, introduction to atomic and molecular spectroscopy.

3.2 Rotational Spectra – Principle, condition, classification of molecules, rotational spectra of diatomic molecules – Rigid rotator (Model), effect of isotopic substitution, applications, numaericals on bond length.

3.3 Vibrational Spectra – Principle, condition, simple harmonic oscillator (Model), force constant and bond energies, applications, numerical on force constant.

3.4 Raman spectra – Introduction, condition, concept of polarizability, quantum theory of Raman scattering, applications.

3.5 Electronic Spectra – Concept of potential energy curve, Frank – Condon principle, types of electronic transitions, applications.

Section B : (Inorganic Chemistry)

Unit – I: Bio Inorganic chemistry : 05 Periods

Definition of Bio-Inorganic chemistry, Essential and Trace elements of Biological importance, Criteria for essential elements. Structure of Metalloporphyrin, Myoglobin and Haemoglobin. Role of myoglobin and haemoglobin in biological process Na^+ - K^+ pump. Haemoglobin as oxygen and CO_2 carrier. Nitrogen fixation : Natural and Artificial Nitrogen cycle.

Unit – II : d-Block Elements : 10 Periods

Definition, Elements of first, second and third transition series, Electronic configuration of first transition series. General characteristics of d-block elements, properties of d-block elements (First transition series) such as: Metallic character. Atomic and ionic radii, Melting and Boiling Points, Ionization enthalpies Reactivity, Oxidation states, Standard electrode potentials, Reducing properties, Colour of ions, Magnetic properties, Catalytic properties and Complex forming tendency.

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Rajarshi Shahu Mahavidyalaya (Autonomous), Latur.

Faculty of Science

B.Sc. III Year (Semester - V)

Chemistry – IX

Paper Code : U-CHE-557(DSEC)

(Physical Chemistry & Inorganic Chemistry)

Marks: 50 **Periods: 45**

Credit: 02 **Weeks: 06**

Learning Objective:

1. To learn the basic alications of electrochemistry.

2.To understand the concepts of overvoltage, determination of overvoltage etc.

3. To study renewable energy resources in detail, solar cells, etc.

4. To learn about metal clusters and their structures

5. To know about structure and bonding in ferrocene

Course Outcome:

After successful completion of the course the students will :

1. Familiarize with the physical phenomenon in biological systems

2. They will learn applications of electrochemistry in daily life

3. Enrich with knowledge of renewable energy resources and their practical applications.

4. To understand the structures of boranes,carboranes etc.

5. To Familiarize with the bonding in ferrocene.

Section: - A (Physical Chemistry)

Unit I: - Applied Electrochemistry **10 Periods**

a. Polarization, concentration polarization and it's elimination
b. Decomposition potential, experimental determination of decomposition potential, factors affecting decomposition potential (nature of electrolyte, nature of electrodes and temperature) Tafel's equation for hydrogen overvoltage, Overvoltage, experimental determination of over -voltage,
c. Electroplating: objectives and procedures

Unit II: - Renewable Energy Sources **10 Periods**

a. Lithium ion cell. Fuel cells; Choice of fuel and oxidant, Bacon's H_2 and O_2 fuel cell.
b. Solar cells, solar energy, photovoltaic effect, semiconductors as solar energy converters, silicon solar cell
c. Hydrogen: Fuel of the future, production of hydrogen by direct electrolysis of water, advantages of hydrogen as a universal energy medium.

Unit III: - Biophysical Chemistry **10 Periods**

a. Biological relevance of chemical potential. Hydrophobic and hydrophilic interactions in biological systems. Protein-Solvent Interactions - preferential binding, hydration and exclusion.
b. Protein-Ligand Binding. Structure-Function relationships. Concept of drug delivery. Traditional and controlled drug delivery system. Carrier based drug delivery pathways. Common modes of drug delivery. Targeted drug delivery. Responsive polymers for drug delivery. Application of nanotechnology in drug delivery.

Section :- B (Inorganic Chemistry)

Unit-I: Metal cluster **10 Periods**

Synthesis, properties, structure of following Metal cluster

1.1) Boranes

1.2) Carboranes

1.3) Metalloboranes

1.4) Metallocarborane

Unit-II: Metallocene **05 Periods**

2.1) Introduction

2.2) Ferrocene: Synthesis, properties, structure and bonding on the basis of VBT.

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Rajarshi Shahu Mahavidyalaya (Autonomous), Latur.
Faculty of Science
B.Sc. III Year (Semester - V)
Chemistry – X
Paper Code: U-CHE-558
(Organic Chemistry & Inorganic Chemistry)

Marks: 50 **Periods: 45**
Credit: 02 **Weeks: 06**

Learning Objective:

1. To write the reactions for synthesis of Polynuclear hydrocarbons and heterocyclic compounds with mechanism

2. To know about synthetic dyes, drugs, pesticides and their preparations.

3.To understand the classification, Constitution and synthesis of Alkaloids and vitamins.

4. To study the different types of Polymers and its synthesis

5.Learn the properties of Lanthanids and their uses.

6.Know about nature of radioactive radiations, Stability of the nucleus etc.

Course Outcome:

After successful completion of the course the students will :

1.Write the reactions for synthesis of naphthalene, anthracene, furan,pyridine etc.with their mechanism

2.Know about methyl orange, Crystal – violet, tolbutamide,paracetamol, sulphanilamide benzocaine and their preparation methods.

3.Can understand the classification,Constitution and synthesis of alkaloids and vitamins.

4. Student will learn the different types of Polymers and its synthesis

5.Learn the properties of lanthanids like oxidation states, ionic radii and lanthanide contraction and their uses.

6.Know about nature of radioactive radiations, Stability of the nucleus etc.

Section: A (Organic Chemistry)

Unit – I Heterocyclic Compounds: 08 Periods

i) Introduction, classification and nomenclature of heterocyclic compounds.

ii) Molecular orbital and resonance structure of five membered and six membered rings.

iii) General Electrophilic substitution reactions & their mechanism.

A) Five membered Heterocyclics:

I) Furan: (Oxole)

i) Synthesis from: a) Mucic acid b) succinaldehyde.

ii) Physical properties.

iii) Chemical properties:

a) Basic nature b) Reduction

c) Diels – Alder reaction d) Electrophilic substitution reactions – Nitration, Sulphonation, Halogenation, Friedel – Craft's acylation, Gattermann-Koch, reaction Gomberg reaction & reaction with n-butyl lithium.

II) Pyrrole : (Azole) :

i) Synthesis from : a) Furan b) Acetylene.

ii) Physical properties.

iii) Chemical properties :

a) Acidic character b) Reduction c) Oxidation

d) Ring expansion e) Electrophilic substitution reactions – Nitration, Sulphonation, Halogenation, Friedel – Craft's acylation, Gattermann reaction, Reimer- Tieman reaction and coupling reaction.

III) Thiophene : (Thiole) :

i) Synthesis from : a) n-butane b) sodium succinate.

ii) Physical properties.

iii) Chemical properties –

a) Reduction b) Electrophilic substitution reactions – Nitration Sulphonation, Halogenation, Friedel – Craft's acylation chloromethylation, Mercuration and reaction with n-butyl lithium.

B) Six – membered Heterocyclics :

I) Pyridine : (Azine) :

i) Synthesis from : a) Acetylene b) pentamethylene diamine hydrochloride.

ii) Physical properties.

iii) Chemical properties –

a) Basic character b) reduction c) Oxidation

d) Electrophilic substitution reactions – Nitration & Sulphonation

e) Nucleophilic substitution reactions – Amination (mechanism).

C) Condensed – Heterocyclics :

I) Indole (Benzopyrrole) :

i) Synthesis by: a) Fischer Indole synthesis b) Reissert Indole synthesis.

ii) Electrophilic substitution reactions.

II) Quinoline (Benzopyridine)

i) Synthesis by : a) Skraup synthesis b) Friedlander synthesis.

ii) Electrophilic substitution reactions.

Unit II – Synthetic dyes, drugs and pesticides : 08 Periods

A) Synthetic dyes:

i) Introduction

ii) Qualities of a good dye.

iii) Colour and chemical constitution (a) Witt's theory (b) Armstrong's theory.

iv) Synthesis and uses of the following:

a) Methyl orange b) Phenolphthalein c) Congo-Red

d) Malachite – Green e) Alizarin f) Crystal – violet

g) Rosaniline h) Diamond black – F

B) Synthetic drugs :

i) Introduction

ii) Qualities of a good drug.

iii) Classification of drugs based on their therapeutic action.

a) Functional drugs: Anaesthetics, antipyretics, analgesics, antidiabetics, sedatives, hypnotics, tranquillizers & anti-inflammatory.

b) Chemotherapeutics: Antibiotics, Antibacterials, antimalarials, antituberculars, antiseptics, antifungals, antivirals and disinfectants.

iv) Synthesis and uses of the following :

a) Tolbutamide b) Paracetamol

c) Sulphanilamide d) Benzocaine e) Isoniazide

C) Pesticides:

i) Introduction

ii) Classification

iii) Impact of pesticides on human health.

iv) Synthesis and uses of the following.

a) 2, 4, 5 – T b) Methoxylchlor

c) Malathion d) Carbaryl

Unit III – Alkaloids and vitamins : 08 periods

A) Alkaloids :

i) Introduction

ii) Occurrence and extraction.

iii) Classification & general properties.

iv) Determination of chemical constitution of alkaloids.

v) Constitution of the following alkaloids :

a) Nicotine: (Synthesis from : nicotinonitrile)

b) Piperine : (Synthesis from piperic acid)

II) Vitamins:

i) Introduction, Classification, Functions and deficiency diseases of the following vitamins

a) Fat soluble vitamins: vitamin – A, D, E & K.

b) Water soluble vitamins: B1, B2, B3, B6, B12 and vitamin – C.

ii) Synthesis of following vitamins: - A, B1, B2, K

Unit-IV Synthetic Polymers: 06 periods

i) Introduction and classification (natural, semisynthetic and synthetic)

ii) Types of polymerization reactions

a) Addition (chain growth) polymerization Free-radical polymerization reaction, Cationic polymerization reaction, Anionic polymerization reaction.

b) Condensation (step growth) polymerization reaction: Nylon-6, Nylon-66.

iii) Synthesis and uses of:

a) Teflon

b) Polystyrene

c) Polyurethanes

d) Buna rubber (Buna-N and Buna-S)

Section B: (Inorganic Chemistry)

Unit – I: f- Block Elements (Lanthanides) : 07 Periods

Definition, position in periodic table, Electronic configuration, Oxidation states, Ionic radii and Lanthanide contraction, Its consequences, Colour of ions, Magnetic properties, Oxidation potential, Basic character of hydroxides, Chemical reactivity, Complexing ability, Important minerals of lanthanides, Separation of lanthanides by ion exchange method and solvent extraction method. Uses of lanthanides.

Unit – II : Radioactivity – I : 08 Periods

Definition, Nature of radioactive radiations, Stability of the nucleus, Factors affecting nuclear stability – Nuclear force, nuclear size. Nuclear density, Packing fraction Mass defect, nuclear binding energy, Odd and Even number of nucleons, Problems based on packing fraction, Mass defect and Binding energy.

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Rajarshi Shahu Mahavidyalaya (Autonomous), Latur.

Faculty of Science

B.Sc. III Year (Semester - V)

Paper Code: U-CHE-559

Laboratory Course – VII

Marks: 50 **Periods: 45**

Credit: 02 **Weeks: 06**

Learning Objective:

1. To acquire practical knowledge of using colorimeter
2. To learn application of tensiometer.
3. To learn the handling of various instruments, study kinetic , phase equilibrium experimentally
4. To learn about the synthesis of inorganic complex preparations

Course Outcome:

1. Students can acquire practical knowledge of to handle colorimeter and perform experiments.
2. students will acquire the knowledge of handling various instruments , theywill study kinetics , phase equilibrium, column chromatography etc
3. Students will acquire the experimental knowledge of synthesis of inorganic complexes.

Note: At least eight experiments be completed (six from Section-A & two from Section–B)

Section A : (Physical Chemistry)

Instrumental :

1) Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture colorimetricaly.
2) To determine the specific refractivity's of the given liquids A and B and their mixture and hence determine the percentage composition their mixture C.
3) Determine the concentration of Cu^{2+} ion in given solution, titrating it against std. EDTA solution by colorimetric measurements.
4) Determine the empirical formula of a complex between Fe^{3+} and 5-Sulphosalicylic acid by Job's method colorimetrically.
5) Determine the equivalent conductance of a strong electrolyte at several concentration and hence verify the Onsager's equation.
6) To determine surface tension by tensiometer

Non instrumental:

1) To determine molecular weight of high polymer (Polyvinyl alcohol) by viscosity measurements.
2) To separate the mixture of o- & p-nitro anilines on an alumina column.
3) Determine interfacial tension between immiscible liquids (benzene and water) by stalagmometer.
4) To study the kinetics of Newton's law of cooling and hence determine the order of reaction
5) The study of energy of activation of second order reaction i.e. reaction between $K_2S_2O_8$ and KI (Unequal concentrations).
6) Freundlich and Langmuir isotherms for adsorption of acetic acid on active charcoal.

Section B : (Inorganic Chemistry)

Inorganic preparations:

1. Preparation of sodium cuprous thiosulphate.

2. Preparation of potassium trioxalatoferrate (III).

3. Preparation of hexamminenickel (II) chloride.

4. Preparation of potassium trioxalatoaluminate (III).

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur.
Faculty of Science
B.Sc. III Year (Semester - V)

Paper Code: U-CHE-559

Laboratory Course – IX (DSEC)

Marks: 50 **Periods: 45**
Credit: 02 **Weeks: 08**

Learning Objective:

1. To acquire skill for handling instruments like potentiometer, PH-meter, polarimeter.

2. To find out the enthalpy of neutralization, energy of activation, amount of ion in given solution by EDTA titrations

3.To analysze various ores and estimate the inorganic ion by gravimetrically.

Course Outcome:

1. Developed the skill for handling instruments like potentiometer, PH-meter, polarimeter and determine dissociation constant, hydrolysis constant of solutions.

2.Can find out the enthalpy of neutralization, energy of activation, amount of ion in given solution by EDTA titrations

3.Can analyse the ore and know about gravimetric estimation of inorganic ion.

Note : At least eight experiments be completed (six from Section A & two from Section – B)

Section A- Physical Chemistry

Instrumental

1. Hydrolysis of NH_4Cl or H_3COONa or aniline hydrochloride by conductomery.
2. Determination of ΔG, ΔH, and ΔS of Silver Benzoate by conductometry.
3. Determination of dissociation constant of an organic acid (CH3COOH) using various buffers (CH3COOH + CH3COONa) pH metrically.
4. Stability constant of a complex ion by using Potentiometer

5. Determination of the acid and base dissociation constants of an amino acid and hence the isoelectric point of the acid by using Potentiometer
6. Determination of half wave potential E ½ and unknown concentration of an ion by using potentiometer
7. Determination of stability constant of ferric-5-sulphosalicylate complex by colorimetric measurements.

Non-Instrumental

1. Investigate the reaction between bromic acid and hydroiodic acid.
2. Partial Molar volume (Pycnometry) determination of the density of a series of
   solutions and to calculate the molar volumes of the components.
3. Hydrolysis constant of aniline hydrochloride by distribution coefficient method.
4. To study kinetics of the reaction between 2,4-dinitrochlorobenzene and piperidine.
5. Determination of solubility diagram for a three component liquid system.
6. Determination of apparent weight and degree of dissociation a strong electrolyte equilibrium methods.

Section B: Inorganic Chemistry

Analysis of Alloys (Any Two) :

1. Analyse the brass alloy for copper content volumetrically.
2. Analyse the Nickel coin (White) for Nickel Content gravimetrically.
3. Analyse the soldermetal for lead content gravimetrically.
4. Analyse the stainless steel for iron content volumetrically.

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Rajarshi Shahu Mahavidyalaya (Autonomous), Latur.

Faculty of Science

B.Sc. III Year (Sem V)

Paper Code: U-CHE-560

Laboratory Course – VIII

Marks: 50 **Periods: 45**

Credit: 02 **Weeks: 06**

Learning Objective:

1.To gain thorough knowledge regarding organic preparations like diazotization, acetlyation, benzoylation etc.

2.To learn about the synthesis of inorganic complex preparation

Course Outcome:

1. Students can know the knowledge regarding organic preparations like diazotization, acetlyation, benzoylation etc.

2. Students can synthesise various inorganic complexes .

Note : At least eight experiments be completed (six from Section A & two from Section – B)

Section A : (Organic Chemistry)

1) Organic Preparations : (Any Six)

(Weight of crude product, crude % yield, recrystallisation of crude product and its melting point expected)

a) Electrophilic Substitution :

I) Preparation of p-nitroacetanilide from acetanilide (Nitration)

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

b) Diazotisation :

I) Preparation of methylorange / methylred.

II) Preparation of o – chlorobenzoic acid from anthyanilic acid.

III) Preparation of p-iodonitrobenzene from p – nitroaniline.

c) Acetlyation :

I) Preparation of acetanilidc / glucose pentaacetate.

II) Preparation of – naphthyl acetate from - naphthol.

d) Hydrolysis :

I) Preparation of p-nitroaniline from p-nitroacetanilide.

II) Preparation of p-bromo aniline from p – bromoacetanilide.

e) Reduction :

I) Preparation of m-nitroaniline from m-dinitrobenzene.

f) Hofmann bromamide Reaction :

I) Preparation of anthranilic acid from phthalimide.

g) Benzoylation :

I) Preparation of benzanilide from aniline.

II) Preparation of napthylbenzoate from – naphthol.

h) Amide formation :

I) Preparation of benzamide from benzoicacid.

i) Oxidation : Preparation of benzoic acid from Toluene.

Section – B (Inorganic Chemistry)

2) Inorganic Preparations:

1. Preparation of potassium trioxalatoaluminate (III). K3 [Fe(C2O4)3].

2. Preparation of sodium hexanitrocobaltate (III).

3. Preparation of cholropentaamminecobalt (III) chloride.

4. Preparation of Chromium (II)acetate Cr(OAc)2

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Rajarshi Shahu Mahavidyalaya (Autonomous), Latur.

Faculty of Science

B.Sc. III Year (Sem V)

Skill Enhancement

Computer Applications in Chemistry

(Theory + Practical)

Marks: 50 **Periods: 45**

Credit:02 **weeks:06**

Objective: To train the students for the use of different Softwares and Excel in chemistry

Course Outcome:

1. Able to know the use of software like chemdraw, chemsketch etc.
2. Able to use the excel for data analysis in Chemistry

Computer Applications in Chemistry

Unit I: Use of Softwares: **10 Periods**

ISIS draw, Chem draw and Chem sketch for drawing the structures, elemental (CHN) analysis, determination of molecular mass, IUPAC name and prediction of spectral data NMR and MASS

Unit II: Use of Excel in Chemistry: **10 Periods**

a) Functions and formulas: Sum, mean, average, power etc. Understanding formulas, the cell and the formula bar, the formula in action, copying formulas, copying and pasting a formula and complex formula.

b) Excel chart and data analysis:

Visual representation of the data through excel graph, plotting and X-Y data set, create calibration curve, format the view graph, add trendline, equation of line and R-square value, determine the slope of a line, scale adjustment, examples, renaming the chart and worksheet, common charting errors, add a chart title. Add regrations and equation to graph, regration analysis, run the regration and interpreting regration results.

Practicals: **25 Periods**

i) Draw the structures of simple aliphatic, aromatic and heterocyclic compounds

ii) Derive chemical structure from its name and vice versa and chemical analysis data

iii) Predict the NMR Signals for a given organic compounds

iv) Draw the organic reactions

v) Draw reaction mechanism scheme

vi) Draw the distillation assembly diagram with chemdraw

vii) Draw bar graph, give legends, chart titles, axis title and error bar

viii) Draw scattered plot. Plot linear graph with regression

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Rajarshi Shahu Mahavidyalaya
(Autonomous), Latur.

Faculty of Science

B.Sc. III Year (Semester - VI)
Chemistry –XI
Paper Code : U-CHE-657
(Physical Chemistry & Inorganic Chemistry)

Marks: 50 **Periods:45**
Credit: 02 **Weeks: 06**

Learning Objective:

1.To understand the concept of electrochemical cells, Nernst equation, application of EMF measurement etc.

2.To learn about Gibbs free energy, Nerns't heat theorem, variation of chemical potential.

3.Familiarize with synthesis and characterization of nanomaterials.

4. Learn the properties of actinides, uses of actinides.

5.To understand nuclear reactions, Q – Value of the nuclear reactions.

Course Outcome:

After successful completion of the course the students will :

1.Understand the concept of electrochemical cells, Nernst equation, application of EMF measurement etc.

2.Learn about Gibbs free energy, Nerns't heat theorem, variation of chemical potential.

3.Familiarize with synthesis and characterization like X-PES, X-ray diffraction, SEM, TEM of nanomaterials.

4. Learn the properties of actinides like electronic configuration, oxidation states etc and uses of actinides.

5.Understand nuclear reactions like nuclear fission,nuclear fusion and Q – Value of the nuclear reactions.

Section A (Physical Chemistry)

Unit - I Electrochemistry – II : 13 Periods

1.1 Introduction, concept of electrode potential – Nernst theory, single electrode potential, standard electrode potential.

1.2 Electrochemical cells – Electrolytic and Galvanic cells, reversible and irreversible cells, conventional representation of an electrochemical cells.

1.3 EMF of a cell, its measurement.

1.4 Reference electrodes – primary (SHE) and secondary (calomel)

1.5 Relation of emf with G, H and S.

1.6 Nernst equation – For single electrode potential and emf of the cell (no derivation).

1.7 Electrolyte concentration cells – concentration cell with transport and without transport, liquid junction potential.

1.8 Application of EMF measurement in determination of pH by using.

a) Quinhydrone electrode.
b) Glass electrode.

1.9 Potentiometric titrations.(Acid-Base, Redox & precipitation)

1.10 Numericals on standard emf of the cell, Nernst equation.

Unit - II Thermodynamics – II : 10 Periods

2.1 Gibbs free energy(G)–Definition, characteristics, significance, variation with T and P.

2.2 Helmholtz free energy (A) – Definition, characteristics, significance, variation with T and V. Relation between G and A.

2.3 Gibb's – Helmholtz equation (derivation)

2.4 The Nerns't heat theorem, third law of thermodynamics.

2.5 Partial molar properties, chemical potential, Gibb's – Duhem equation (Derivation), Variation of chemical potential with T and P.

2.6 Van't – Hoff's isotherm.

2.7 Van't - Hoff's reaction isochore, its integrated form.

2.8 Clausius – Clapeyron equation and its applications.

2.9 Thermodynamic derivation of law of mass action.

2.10 Numericals on Van't – Hoff's isotherm, Van't – Hoff's isochore & Clausius Clapeyron equation.

Unit – III Introduction to nanotechnology : 07 Periods

3.1 History, background & scope of nanotechnology.

3.2 Synthesis of nanomaterials : Chemical methods - such as chemical precipitation method, sol-gel method, chemical reduction method.

3.3 Characterization of nanomaterials by different methods such as: X-PES, X-ray diffraction, SEM, TEM.

Section B : (Inorganic Chemistry)

Unit – I f-block elements (Actinides): 07 Periods

Definition, position in periodic table, occurrence of actinides, electronic configuration, oxidation states, general methods of preparation of transuranic elements, IUPAC nomenclature of supra heavy elements with atomic number greater than 100. Uses of Actinides Comparision between Lanthanides and Actinides.

Unit – II Radiochemistry II: 08 Periods

Nuclear models – Nuclear shell model, liquid drop model. Nuclear reactions a) based on nature of bombarding particles, b) based on transformation of nucleus. Nuclear fission reaction – principle of atomic bomb, Q – Value of the nuclear reaction, Nuclear fusion reaction – Principle of hydrogen bomb. Indias nuclear energy program.

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Rajarshi Shahu Mahavidyalaya (Autonomous), Latur.
Faculty of Science
B.Sc. III Year (Semester - VI)
Chemistry - XII
Paper Code: U-CHE-658
(Organic Chemistry & Inorganic Chemistry)

Marks: 50 **Periods: 45**
Credit: 02 **Weeks: 06**

Learning Objective:

1. To understand different types of spectroscopy and their applications to organic compounds.

2. To learn the reactions of amino acids, peptides and proteins

3.To understand different rearrangement reactions and reagents.

4. To study organic reactions involving enolates as intermediate

5.To familiarize the students with molecular orbital theory and non transition elements like silicates, zeolites and carbides.

Course Outcome:

After successful completion of the course the students will :

1.Understand about U.V, I.R, NMR spectroscopy and their applications to organic compounds.

2.Write the reactions of amino acids, peptides and proteins with their mechanisms

3.Know about how to write different rearrangement reactions like Pinacol – Pinacolone Baeyer – Villiger, Wolf and Hofmann reactins and the uses of different reagents in synthesis.

4.Understand organic reactions involving enolates as intermediate.

Familiarize with molecular orbital theory and non transition elements like silicates, zeolites and carbides etc.

Section A (Organic Chemistry)

Unit – I Spectroscopy: 12 Periods

i) Introduction, Electromagnetic radiations & Electromagnetic spectrum.

ii) Characteristics of Electromagnetic radiations.

iii) Types of Spectroscopy, Advantages of spectroscopic methods.

I) U.V. Spectroscopy:

i) Introduction

ii) Absorption of U.V. radiations : Absorption laws.

iii) Principle of U.V. Spectroscopy

iv) Types of Electronic transitions

v) Terms used in U.V. spectroscopy.

a) Chromophore b) Auxochrome

c) Bathochromic Shift or Effect d) Hypsochromic Shift or Effect

e) Hyperchromic Effect f) Hypochromic Effect

vi) Effect of conjugation on position of U.V. and visible bands.

vii) Woodward – Fieser rules for calculating max of conjugated dienes, polyenes and enones.

viii) Spectral problems based on U.V.

II) I.R. Spectroscopy :

i) Introduction

ii) Principle of I.R. Spectroscopy

iii) Molecular Vibrations, Hooke's law

iv) Requirement for the absorption of I.R. radiations.

v) I.R. Spectrum : Functional group region and Finger print region.

vi) Factors affecting vibrational frequencies.

vii) Characteristic absorption frequencies of functional groups.

viii) Interpretation of I.R. spectra of following organic compounds :

a) Ethane	b) Ethene	c) Ethyne	d) Benzene	e) 1-Propanol
f) 2- Propanol	g)t-butyl alcohol	h) Phenol	i) Acetone	j) Acetophenone
k)Acetaldehy	l) Benzaldehyde	m)Benzoic acid	n)Methylbenzoe	o)Phenylcyanide
p) Aniline				

III) NMR – Spectroscopy :

i) Introduction

ii) Principle of NMR Spectroscopy.

iii) Magnetic and non-magnetic nuclei.

iv) PMR–Spectroscopy: Spinning nuclei, Magnetic moment, Magnetic field, precessional motion, Orientations of proton, nuclear resonance & absorption signals.

v) Equivalent and Non – equivalent protons.

vi) Number of PMR signals in the following compounds :

a) Acetone	b) Cyclobutane	c) Methanol	d) Ethylbenzene
e)Ethylamine	f) Mesitylene	g) Diethylether	h) Toluene
i) Allylalcohol	j) Ethanol		

vii) Shielding and Deshielding of protons. (Examples of acetylene and benzene)

viii) Chemical Shift & Measurement of Chemical Shift.

ix) TMS as a standard substance for recording chemical shift.

x) Spin – Spin Coupling : Splitting of PMR Signals.

xi) Coupling Constant : (J – Values) of first order coupling.

xii) Peak area & its significance.

xiii) Interpretation of PMR spectrum of following compounds:

a) Ethylbromide	b) Ethylalcohol	c) Acetaldehyde
d) Ethylacetate	e) Ethylamine	f) Toluene
g) Acetophenone	h) Acetic acid	i) Benzoic acid
j) 1,1,2-Tribromoethane		

xiv) Problems pertaining to the structure elucidation of simple organic compounds using PMR – spectroscopic data. (Supporting IR and UV data to be given)

Unit – II : Amino acids and peptides: 06 Periods

I) Amino acids :

i) Introduction and classification.

ii) Dipolar nature of amino acids ; Zwitter ion, Iso- electric point.

iii) Methods of preparation of Amino acids :

a) From -Haloacids b) By Strecker's synthesis

iv) Chemical Properties of - amino acids :

a) Reactions due to – NH_2 group.

b) Reactions due to – COOH group.

c) Reactions due to both – NH_2 and – COOH groups.

v) Reagents used for identification of amino acids.

II) Peptides:

i) Introduction, Classification and Nomenclature.

ii) N-Terminus and C –Terminus protecting agents.

iii) Synthesis of peptides from amino acids:

a) By protecting – NH_2 group.

b) By protecting – COOH group.

iv) Methods for identifying N-terminal and C- terminal groups

Unit – III Molecular Rearrangements and Reagents: 06 Periods

I) Rearrangements:

i) Introduction.

ii) Types of molecular rearrangements.

iii) Study of following rearrangements with mechanism.

a) Pinacol – Pinacolone b) Baeyer – Villiger c) Wolf d) Hofmann

e) Beckmann f) Benzilic acid

II) Reagents :

i) Introduction

ii) Synthetic applications of following reagents in organic synthesis.

a) Osmium tetra oxide (OsO_4)	b) N – Bromo succinimide (NBS)	c) Lead Tetra acetate $Pb(CH_3COO)_4$
d) Lithium Aluminium hydride ($LiAlH_4$)	e) Selenium dioxide (SeO_2)	f) Anhydrous Aluminum Chloride (AlCl3)

Unit IV: Organic Synthesis via Enolates. 06 periods

i) Introduction: Active methylene compounds
ii) Preparation of ethylacetoacetate by claisen condensation with mechanism
iii) Keto-enol tautomerism
iv) Acidic and ketonic hydrolysis of ethylacetoacetate
v) Synthetic applications of ethylacetoacetate

Section B : (Inorganic Chemistry)

Unit – I : Molecular orbital theory 10 Periods

Comparison of VBT and MOT of covalent bonding Atomic and molecular orbitals. Linear combination of atomic orbitals. Bonding and Antibonding molecular orbitals sigma and molecular orbitals. Energy level diagram of Homonuclear diatomic molecules of H_2, He_2, N_2, O_2, O_2^+, O_2^-, O_2^{2-} Bond order, Energy level diagram of hetero nuclear diatomic molecules of HCl, NO, CO.

Unit-II: Chemistry of non transition elements **05 periods**

a. Silicates, definition, unit of silicates, Classification on the basis of basic units and their characteristics.

b. Zeolites: Definition, preparation and classification and application, ultramarine

c) Carbides: Definition, classification, preparation, properties and structures of ionic or salt like carbides e,g. (CaC_2), metallic carbides (TiC) & covalent carbides (SiC)

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Rajarshi Shahu Mahavidyalaya (Autonomous), Latur.
Faculty of Science
B.Sc. III Year (Semmester - VI)
Chemistry - XII
Paper Code: U-CHE-658 (DSEC)
(Organic Chemistry & Inorganic Chemistry)

Marks: 50 **Periods: 45**
Credit: 02 **Weeks: 06**

Learning Objective:

1. To study the analysis of organic compounds

2. To learn the different types of organometallic compounds

3.To understand different organic named reactions.

4. To study different types of biomolecules.

5.To study various types of electronic transitions spectra and basic knowledge of inorganic polymers.

Course Outcome:

After successful completion of the course the students will :

1. Able to understand the analysis of organic compounds

2. To learn the different types of organometallic compounds

3.Able to understand different organic named reactions.

4.Students will be familiar with different types of biomolecules.

5. Familiarize with d-d transitions, splitting factors, classification, preparation and uses of inorganic polymers.

(Section-A Organic Chemistry)

Unit I:- Analysis of organic compounds **08 periods**

i) Detection of elements

a) Detection of C & H

b) Detection of N, S & X

ii) Estimation of elements

a) Estimation of C & H

b) Estimation of N

c) Estimation of halogens

iii) Determination of empirical, molecular formula and numericals based on it

iv) Determination of molecular weight

Unit II:- Organometallic compounds **08 periods**

Introduction, Nomenclature, carbon-metal bond in organometallic compounds.

A) Organo Lithium Compounds:

i) Preparation of organolithium compounds

ii) Synthetic applications of organo lithium(RLi)

B) Organocopper Compounds:

i) Preparation of organocopper compounds (Lithium dialkyl cuprate)

ii) Synthetic applications of Organocopper Compounds

C) Organotin Compounds:

i) Preparation of organotin compounds.

ii) Synthetic application of organotin compounds

Unit III:- Organic named reactions **08 periods**

A] Name Reactions with Mechanism :

i) Arndt-Eistert reaction

ii) Biginelli Reaction

iii) Favorskii Reaction

iv) Suzuki reaction

v) Michael addition reaction

vi) Hell-Volhard- Zelinsky reaction

vii) Shapiro reaction

viii) Chichibabin reaction

Unit IV:- Biomolecules **06 periods**

A) Proteins:

i) Introduction.

ii) Classification

iii) Difference between polypeptides & Proteins

iv) Structures of proteins:

a) Primary structure
b) Secondary structure
c) Tertiary structure
d) Quaternary structure

v) Renaturation & Denaturation of proteins.

B) Nucleic Acids:

i) Introduction

ii) Constituents of Nucleic Acids

iii) Nucleosides

iv) Nucleotides

v) Three dimensional structure of DNA

(Section-B Inorganic Chemistry)

Unit- I: Electronic Spectra of Transition Metal complexes: 05 Periods

1.1) Types of electronic transition

1.2) Selection rule for d-d transistion

1.3) Spectroscopic ground state and spectro-chemical series

1.4) Orgel energy level diagram for d1 and d9 states

1.5) Discussion of electronic spectrum of [Ti (H2O)6] 3+ complex ion

Unit-II: Inorganic Polymers 10 Periods

2.1 Introduction

2.2 Basic concepts and definition

i) Polymer ii) Monomer iii) Polymerization iv) Copolymer v) Degree of polymerization

2.3 Classification of polymers on basis of : i) Origin ii) Composition iii) Properties iv) Uses

2.4 Comparison between organic and inorganic polymers

2.5 Polymer backbone

2.6 Homoatomic polymers containing-phosphorus

2.7 Heteroatomic polymers i) Silicones ii) Phosphonitrilic compounds iii) Fluorocarbons.

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Rajarshi Shahu Mahavidyalaya (Autonomous), Latur.
Faculty of Science
B.Sc. III Year (Semester - VI)
Paper Code : U-CHE-659
Laboratory Course – IX

Marks: 50 **Periods: 45**
Credit: 02 **Weeks: 08**

Learning Objective:

1. To acquire skill for handling instruments like potentiometer, PH-meter, polarimeter.

2. To find out the enthalpy of neutralization, energy of activation, amount of ion in given solution by EDTA titrations

3. To find out the standard free energy change ΔG^0 and equilibrium constant, etc.

4.To learn about the synthesis of inorganic complex preparation

Course Outcome:

1. Developed the skill for handling instruments like potentiometer, PH-meter, polarimeter and determime dissociation constant, hydrolysis constant of solutions.

2. Students can find out the enthalpy of neutralization, energy of activation, amount of ion in given solution by EDTA titrations

3. Students can find out the standard free energy change ΔG^0 and equilibrium constant, etc.

4.Students can synthesize various inorganic complexes.

Note : At least eight experiments be completed (six from Section A & two from Section – B)

Section A : (Physical Chemistry)

Instrumental:

i) Determination of dissociation constant of an organic acid (CH_3COOH) using various buffers ($CH_3COOH + CH_3COONa$) pH metrically.

ii) To determine the hydrolysis constant of an aniline hydrochloride by pH measurement.

iii) To study the inversion of cane sugar by polarimetrically.

iv) Determine the equivalent conductance of a strong electrolyte at several concentration and hence verify the Onsager's equation.

v) To prepare standard 0.2 M $Na2HPO_4$ and 0.1 M Citric acid solution, hence prepare four different buffer solutions using them. Determine the pK_a value of these and unknown solutions potentiometrically.

Non–instrumental :

i) To determine the standard free energy change ΔG^0 and equilibrium constant for the reaction. $Cu + 2\ Ag^+ \rightarrow Cu^{+2} + 2Ag$

ii) To determine the molecular state of Benzoic Acid by distribution method .

iii) To determine energy of activation of hydrolysis of an ester by acid / base.

iv) Determination of latent heat of fusion of a given solid.

v) Determine molecular weight of non volatile solute by Rast method / Beckomann's freezing point method.

Section B : (Inorganic Chemistry)

Inorganic Preparations:

1. Preparation of Manganese (III) acetylacetonate [Mn(acac)3].
2. Preparation of Tris(Thiourea)Copper (I) Chloride [Cu (Thiourea)3]Cl.
3. Preparation of ammonium diamminetetrathiocynatochromate
4. Preparation of tris (ethylene diamine)nickel (II) thiosulphate.

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur.
Faculty of Science
B.Sc. III Year (Semester - VI)
Paper Code : U-CHE-660
Laboratory Course – X

Marks: 50 **Periods: 45**
Credit: 02 **Weeks: 06**

Learning Objective:

1. Develop experimental skills in Separation of organic binary mixture containing two solid components.

2. To learn about the synthesis of inorganic complex preparation

Course Outcome:

1.Students can do Separation of organic binary mixture containing two solid components.

like Acid + Phenol, Phenol + Base, Base + Neutral etc.

2.Can To learn about the synthesis of inorganic complex preparation.

Note: At least eight experiments be completed (six from Section-A & two from Section–B)

Section A : (Organic Chemistry)

Organic Qualitative Analysis : (Six mixtures)

[Separation of organic binary mixture containing two solid components, using $NaHCO_3$, NaOH and HCl & Analysis of one component with preparation of derivative]

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

a) Acid + Phenol b) Acid + Base c) Acid + Neutral

d) Phenol + Base e) Phenol + Neutral e) Base + Neutral

Following compounds are to be used for the preparation of binary mixtures:

A) Acids: Benzoic acid, Salicylic acid, Cinnamic acid, Phtalic acid and o/ m – chlorobenzoic acid.

B) Phenols: α- naphtol, β- naphthol o/m/p nitro- phenols.

C) Bases: o/m/ p- nitroanilines , p- Toluidine, diphenylamine, p – chloroaniline.

d) Neutrals: Acetanilide, naphthalene, anthrancene m- dinitrobenzene, benzophenone

Section: - B Inorganic Chemistry

Inorganic Preparations:

1.Preparation of Mercury tetrathiocyanato Cobaltate (II)Hg[Co(SCN)4]

2. Preparation of Magnesium oxinate[Mg(Ox)2]

3. Preparation of Tris-acetyl acetonato iron(III)[Fe(AcAc)3]

4. Preparation of Tetrammine copper(II) sulphate.[Cu(NH3)4]SO4.H2O

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Rajarshi Shahu Mahavidyalaya (Autonomous), Latur.

Faculty of Science

B.Sc. III Year (Semester - VI)

Paper Code : U-CHE-660

Laboratory Course – VIII (DSEC)

Marks: 50 **Periods: 45**

Credit: 02 **Weeks: 06**

Learning Objective:

1. To gain thorough knowledge regarding organic preparations like hydrolysis, Oxidation, reduction etc.

2. To gain the knowledge of analysis of ores and volumetric estimation

Course Outcome:

1. Students can know the knowledge regarding organic preparations like hydrolysis, Oxidation, reduction etc.

2. They acquire the knowledge of analysis of various ores and volumetric estimation.

Note : At least eight experiments be completed (six from Section A & two from Section – B)

Section A : (Organic Chemistry)

1) Organic Preparations : (Any Three)

(Weight of crude product, crude % yield, recrystallisation of crude product and its melting point expected)

a) Electrophilic Substitution :

i) Preparation of 1- nitro naphthalene from naphthalene.

b) Hydrolysis :

i) Preparation of benzoic acid from benzamide.

c) Reduction :

i) Preparation of beta amino beta phenyl propionic acid from cinnamic acid.

d) Oxidation:

i) Preparation of benzil from benzoin.

2) Organic Estimations : (Any Three)

i) Estimation of acetone.

ii) Estimation of aniline.

iii) Estimation of basicity of organic acid.

iv) Estimation of carbonyl group by hydrazone formation method.

Section B : (Inorganic Chemistry)

Analysis of Ores

a) Analyse the Haematite ore for iron content volumetrically.

b) Analyse the dolomite ore for calcium content by EDTA method.

c) Analyse the pyrolusite ore for manganese content by oxalic acid method.

d) Analyse the bauxite ore for aluminium content by oxinate method.

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Rajarshi Shahu Mahavidyalaya (Autonomous), Latur.

Faculty of Science

B.Sc. III Year (Sem VI)

Skill Enhancement

Cosmetics & Chromatographic techniques (Theory + Practicals)

Marks: 50 **Periods: 45**

Credit:02 **weeks:06**

Course Objective:

1.This course aims to give clear understanding of the basic concept cosmetics preparation

2. To understand chromatographic Techniques in Chemistry

Course Outcome:

1. To train the students for the preparation of various cosmetics

2. Able to carry out separation by using different chromatographic Techniques

Unit I:- Preparation of cosmetics **10 Periods**

i) Preparation of Soap

ii) Preparation of talcum powder

iii) Preparation of shampoo

iv) Preparation of face cream

v) Preparation of nail polish and nail polish remover

Unit II:- Chromatographic Techniques in Chemistry 10 Periods

Introduction, Classification, Principle of Chromatography, Types of solvents used, Sample preparations, Paper Chromatography, Thin layer Chromatography, Column Chromatography, HPLC and Gas Chromatography and applications of chromatography

Practicals:

i) Preparation of Soaps

ii) Preparation of Shampoo

iii) Separation of amino acids by using Paper chromatography

iv) Monitoring single stage preparation by using Thin layer chromatography

v) Separation of organic mixtures by column chromatography

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Reference Books (Organic Chemistry)

1. Organic Chemistry : S.M. Mukherji, S.P. Singh and R.P. Kapoor (Vol – II & III)
2. Organic Chemistry : Jagdamba Singh and L.D.S. Yadav (Vol. II & III)
3. A Text book of Organic Chemistry : Arun Bahl and B.S. Bahl.
4. A Text book of Organic Chemistry : K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra.
5. A Text book of Organic Chemistry : P.L. Soni and H.M. Chawla.
6. Principles of Organic Chemistry : M.K. Jain.
7. Natural Products : O.P. Agarwal (Vol. I & II)
8. Synthetic Organic Chemistry : Gurdeep R. Chatwal.
9. Spectroscopy of Organic Compounds : P.S. Kalsi.
10. Elementary Organic Absorption Spectroscopy : Y.R. Sharma.
11. Chemistry of Pesticides : K.H. Buchel (T.W.)
12. Elements of Toxicology : Kamlesh Pandey & J.P. Shukla.
13. Medicinal Chemistry : Burger.
14. Reactions, rearrangements and reagents : S.N. Sanyal.

15. Industrial chemistry : B.K. Sharma.
16. Synthetic dyes : G.R. Chatwal.
17. A Text book of synthetic drugs : O.D. Tyagi & M. Yadav.
18. Synthetic Organic Chemistry : Kamlesh Bansal.
19. An introduction to analytical chemistry, S. A. Iqbal, M. Satake, Y. Mido and M. S. Shethi.
20. College analytical chemistry: Joshi, Baliga and Shetty, Himalaya Publishing house.
21. Quantitative Analysis-R.A Day and A.L Underwood.

References : (Physical Chemistry)

1. Physical Chemistry by G.M.Barrow (Tata Mc – Graw Hill publishing Co., Ltd.)
2. Elements of Physical Chemistry by S.Glasstone & D. Lewis (D.vannostrand co.inc.)
3. Physical Chemistry by W.J. Moor (Orient Longman)
4) Principles of Physical Chemistry by S.H. Maron and C.F. Prutton.
5) University General Chemistry by C.N.R. Rao (Mc-Millan).
6) Elements of Physical Chemistry by P.W. Atkins. (Oxford University Press.)
7) Physical Chemistry by R.A. Alberty (Willey Eastern Ltd.)
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10)Physical Chemistry by A.J. Mee. ELBS & Heinemann Educational Books Ltd.
11)Essentials Physical Chemistry by Arun Bhal, B.S. Bahl and G.D. Tuli (S. Chand).
12)Chemical Kinetics by K.J. Laidler (Tata Mc-Graw Hill Publishing Co. Ltd.)
13)Text Book Physical Chemistry by Soni – Dharmarha.
14)A Text Book Physical Chemistry by S. Glasstone, (Mac Millan)
15)Advanced Physical Chemistry by D.N. Bajpai. (S. Chand)
16)Advanced Physical Chemistry by Gurdeep Raj. (Goel publishing house, Meerut).
17)Biophysical Chemistry ,Gurtu and Gurtu, Pragati Edition, 2007.
18)Physical Chemistry, Principles and Applications in Biological Sciences
19)Tinico, K. Sauer, J. Wang and J. D. Puglisi, 4th Edition, Pearson Edition, 2007.
20)Biophysical Chemistry , A. Upadhyay, K Upadhyay and N. Nath, Himalaya Publishing

House, 2005.

21)Biophysical Chemistry , James P. Allen,

22)Biophysical Chemistry , C. R.Cantor and P.R. Schimmel, WH Freeman & Company, New York, 2004.

23)An Introduction to Electrochemistry by S. Glasstone

24)Modern Electrochemistry Vol. I & II by J. O. M. Bockris and A.K.N. Reddy.

25)Electrolytic Solutions by R. A. Robinson and R. H. Strokes, 1959

26)Kinetics and Mechanism - A. A. Frost and R. G. Pearson.

27)Electrochemistry- S. Glasstone, D. Van Nostrand , 1965

References : (Inorganic Chemistry)

1. Concise Inorganic Chemistry by J.D. Lee.
2. Advanced Inorganic Chemistry by F.A. Cotton and Wilkinson.
3. Inorganic Chemistry by A.G. Sharp.
4. Inorganic Chemistry by Miessler and Tarr.
5. Chemistry for degree students, B.Sc. TY by R.L. Madan.
6. Advanced Inorganic Chemistry by Gurudeep Raj and Chatwal Anand.
7. Principles of Inorganic Chemistry by Puri – Sharma and Kalia.
8. Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson and P.L.Gaus.
9. Advanced Inorganic Chemistry Vol. – I, Vol. – II by Satyparakash, Tuli, Basu and Madan.
10. Inorganic Chemistry by Huhcey, Keiter and Keiter.

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References : (Practical's)

1) Practical Organic Chemistry by A.I. Vogel.
2) Advanced Practical Organic Chemistry by O.P. Agarwal.
3) Advanced Practical Organic Chemistry by N.K. Vishnoi.
4) Handbook of Organic qualitative analysis by H.T. Clarke.
5) A Laboratory Hand book of Organic Qualitative Analysis by V.S. Kulkarni.
6) Advanced inorganic analysis by Agarwal, Keemtilal.
7) Experiments in chemistry by Dr.D.V. Jahagirdar
8) Advanced inorganic chemistry experiments by – Gurtu – Gurtu.
9) Advanced practical inorganic chemistry by – Gurudeep Raj.
10) Experiments in inorganic chemistry by – Gurtu and Kapoor.
11) Advanced practical chemistry by J.B. Yadhav.
12) Systematic experimental physical chemistry – S.W. Rajbhoj and T.K. Chondhekar.
13) Experimental physical chemistry by R.Daniel and others.
14) Experiments in physical chemistry by R.C. Das and Behere
15) Experiments in General Chemistry by C.N.R. Rao

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