SAURASHTRA UNIVERSITY

B.Sc. SEMESTER – V

CHEMISTRY [C-501] SYLLABUS

INORGANIC CHEMISTRY AND INDUSTRIAL CHEMISTRY

UNIT-1

Chapter-1: Multi Electron System [12 Hours]

- Introduction
- Concept of spectral terms and term symbols
- s-s coupling, l-l coupling, l-s coupling, j-j coupling and L-S coupling with vector diagram.
- Derivation of spectral term symbol for P^1, P^2, P^3, & d^1 to d^9
- Micro states: Definition, calculation and derivation of microstates for p^1, p^2, d^1 & d^2
- Hole-Pigeon diagram
- Hund's rule for the determination of ground state spectral term
- All type of examples including calculation of S. Ms, L, M_L, J, M_J and microstates.
- Hole formalism
- Splitting of D and F ground terms using hole formalism
- Orgel Diagram of D and F states

UNIT-2

Chapter-2: Crystal Field Theory [12 Hours]

- Introduction
- Concept of crystal field theory
- d-orbitals splitting and CFSE in octahedral and tetrahedral filed with examples
- Weak field and strong field ligands
- Factor affecting splitting energy.
- Jahn-Teller effect: Statement and explanation
- Tetragonal distortion with example
- Splitting of d-orbital in square planar complexes with examples
- High spin and low spin complexes with paring energy with Examples
- Magnetic behaviour of transition metal complexes
- Orbital angular momentum contribution to magnetic momentum of complexes

UNIT-3

Chapter-3: Basics of Electronic Spectra of Transition Metal Complexes [06 Hours]

- Introduction to the concept
- Selection rules for d-d transition
- Relaxation in selection rules
- Characteristics of Absorption Spectrum
- Types of electronic transition in metal complexes
- Discussion of Absorption spectrum of Ti^{+3}, Cu^{+2} & Ni^{+2}

Chapter-4: Glass [06-hours]

- Introduction
- Physical and chemical properties of glass
- Raw materials for glass manufacture
- Chemical reactions involved in glass manufacture
- Manufacture process: Formation of batch material, Melting, Shaping,
- Annealing, and Finishing.
- Special type of glass: Fused silica glass, High silica glass, optical glass, borosilicate glass, lead glass, glass wool, Pyrex glass, photochromic glass, insulating glass, rare earth glass, vitreosil glass, photosensitive glass.

UNIT-4

Chapter-5: Fertilizers [12 hours]

- Introduction to fertilizers, role of plant nutrients.
- Classification and properties of fertilizers.
- Nitrogenous fertilizers.
- Manufacturing process of (1) Ammonium nitrate (by prilling method), (2) Ammonium sulphate (sindri process), (3) Urea (from Ammonium carbonate), (4) Calcium cyanamide(by electro carbonate) and action of fertilizers(of all above).
- Phosphate fertilizer: (1) Normal super phosphate and its manufacturing process, (2) Triple super phosphate and its manufacturing process, (3) manufacture of mono ammonium and diammonium phosphate.
- Potassium fertilizer: NPK fertilizers and nomenclature, Murate of potash and Karnelite from sea water
- Comparison of Natural and Synthetic Fertilizers

UNIT-5

Chapter-6: Cement **[12 hours]**

- Introduction and type of cement.
- Raw materials and manufacturing process (1) Dry process (2) Wet process.
- Setting of cement (1) Hydrolysis (2) Hydration.
- Properties of cement.
- Testing of cement and ISI specification of cement.
- Mortar, concrete, RCC
- Curing and decay of cement.
- Uses of cement.

CHEMISTRY [C-502] SYLLABUS
ORGANIC CHEMISTRY AND SPECTROSCOPY
EFFECTIVE FROM JUNE-2021

UNIT-I:

1. Name Reactions and Rearrangements: [6 hours]

Reactions

a) Arndt Eistert reaction
b) Bischler Napieralski reaction
c) Perkin Reaction
d) Reformatksy Reaction
e) Oppenauer Oxidation

Rearrangements

a) Favorskii Rearrangement
b) Curtius rearrangement
c) Bayer-villiger oxidation

2. Alkaloids [6 hours]

Introduction, Occurrence, classification, Isolation, Constitution, Properties and synthesis of

a) Coniine
b) Nicotine
c) Papaverine

UNIT-II:

1. Carbohydrates [8 hours]

Introduction, classification and nomenclature, [general reaction of monosaccharides (with reference to Glucose and Fructose) for reference only]

Inter-conversions of monosaccharides:

a) Conversion of Aldose to the corresponding ketose via osazone formation
b) Conversion of Ketose to the corresponding Aldose
c) Step-up reaction (Ascending in Aldose series): Kiliani reaction, Swoden nitromethane reaction
d) Step-down reaction (Descending in Aldose series – Aldohexose to Aldopentose) by Ruff's method

Configuration of monosaccharides- Glucose and Fructose

Ring structure of Aldoses

Determination of ring size of Glucose by

a) Methylation method
b) Periodic oxidation method

Mutarotation of D (+) glucose

2. Polynuclear Aromatic Hydrocarbons [4 Hours]

Introduction, Classification of Polynuclear hydrocarbon, Synthesis and chemical properties:

a) Biphenyl
b) Diphenyl methane
c) Naphthalene
d) Anthracene

UNIT-III:

1. Synthetic Drugs, Dyes and Sweetening Agents [3 hours]

Synthesis and applications of

Drug:

a) Ibuprofen
b) Atenolol
c) Adrenaline

Dyes:

a) Orange II
b) Crysoidine G
c) Auramine O

Sweetening agent:

a) Saccharin
b) p-anisylurea
c) Aspartame

2. Conformational Isomerism [3 Hours]

Conformation of cyclic system: Cyclohexane

Conformational analysis of cyclohexane: Boat form and Chair form

Conformation of mono-substituted and di-substituted cyclohexane

3. Ultraviolet and Visible Spectra **[6 hours]**

Introduction: Theory

Instrumentation- UV Spectrophotometer

Types of transition in organic molecules

Transition Probability: Allowed & Forbidden transitions

Chromophore Related terms:

a) Chromophore

b) Change in position and intensity of absorption: Bathochromic shift, Hypsochromic shift, hyperchromic effect and hypochromic effects

c) Auxochrome

Effect of Conjugation on UV spectral bands

Effect of Solvent on UV spectral bands

Woodward – Fieser Rules for Calculation of Absorption Maxima (λ_{max})

Calculation of λ_{max} in:

i. Conjugated dienes

ii. Enones

iii. α, β -aromatic carbonyl system

Factors affecting of UV spectral bands

Application of UV spectroscopy to Organic Chemistry

UNIT-IV: **[12 hours]**

1. Molecular Symmetry

Introduction

Symmetry elements and symmetry operations with illustrations

Definition of symmetry point group, subgroup and classes

Products of symmetry operations

Symmetry point group [C_1, C_s, C_i, C_n, C_{nv}, D_n, D_{nh}, D_{nd}, C_v, $D_{\alpha h}$, Td, Oh];

Multiplication tables for C_{2v}, C_{3v} and C_{2h} point groups.

UNIT-V:

1. Infrared Spectroscopy **[12 hours]**

Introduction: Range of IR

Theory of IR / Requirements for IR absorption (Not mathematical theory)

IR Instrumentation

Modes of fundamental vibrations

Factors influencing Vibrational Frequencies:

a) Coupled vibrations & Fermi resonance
b) Electronic effects
c) Hydrogen bonding

Force constant

Position and Intensity of IR spectral bands: Finger print region

Applications of IR Spectroscopy to Organic Compounds

Limitations of IR spectroscopy

Determination of structure of organic molecules from IR spectra

Interpretation of IR for given molecules and problems

SAURASHTRA UNIVERSITY

B.Sc. SEMESTER – V

CHEMISTRY [C-503] SYLLABUS

PHYSICAL CHEMISTRY AND ANALYTICAL CHEMISTRY

EFFECTIVE FROM JUNE-2021

UNIT-I:

1. Second law of thermodynamics [12 hours]

- Limitations of first law of thermodynamics
- Spontaneous process
- Carnot cycle & theorem
- Statements of second law of thermodynamics
- Perpetual motion machine of the second kind (briefly)
- Concept of entropy, Definition and Characteristics of Entropy
- ΔS in reversible & irreversible (spontaneous) process
- ΔS in physical transformations
- ΔS in ideal gases
- ΔS of mixture of ideal gas
- Entropy and second law of thermodynamics
- Examples based on theory

UNIT-2

1. Electrochemistry-1 [8 hours]

- Introduction to basic concepts related to electrochemistry (e.g. oxidation, reduction, redox reaction, electrolytes and their types, oxidation number, oxidation potential, reduction potential etc)
- Differences between “electrochemical cell” and “electrolytic cell”.
- Electrode, Half-cell, electrochemical cell
- standard half-cell, standard electrochemical cell
- Types of electrodes such as Metal-Metal ion electrode, Metal-metal insoluble salt electrode, Metal-Metal amalgam electrode, Gas electrode and Inert (Redox type) electrode
- Conventional sign and representation of electrochemical cell (Galvanic cell)
- Standard electrode potential and its measurement

- emf series
- Hydrogen electrode, calomel electrode, glass electrode

- Reversible cell and Irreversible cell
- Nernst equation for the calculation of single electrode potential
- Examples based on theory

2. Phase rule [4 hours]

- Three component system, maximum degree of freedom and minimum degree of freedom for three component system
- Method of graphical presentation
- Different types of three component systems

  (1)One pair of partially miscible liquids: Effect of adding third component,

  Nature of tie line, Plait point, Binodal curve, Characteristics of phase diagram,

  (2)Formation of two pairs of partially miscible liquids, effect of temperature on phase diagram

  (3)Formation of three pairs of partially miscible liquids
- Application of ternary liquid diagram

UNIT-3

1. Free energy and chemical equilibrium [8 hours]

- Work function: its physical significance and variation with V and T
- ΔG for ideal gases, Gibbs Helmholtz equation and its applications
- Free Energy: its significance & variation with P and T
- Criteria for the reaction to be spontaneous or in chemical equilibrium state with respect to different thermodynamic function like E, H, A, S and G
- Law of mass action and its derivation with help of Vant Hoff equilibrium box
- Vant Hoff isotherm equation
- Derivation of Vant Hoff isochor equation and its integral form
- Clausius-Clapeyron equation and its integral form
- Effect of pressure on (i) the melting point of ice, (ii) the boiling point of water and (iii) the melting point of paraffin wax
- Examples based on the theories

2. Colourimetry [4 hours]

- Introduction
- Grotthuss Draper law, lambert's law, Beer's law, lambert's-beer's law and

Derivation, application & deviation of lambert's law

- Spectrophotometric titration with graph and proper explanation
- Deficit of absorbance by product and titrant
- Deficit of absorbance by product and reagent
- Deficit of absorbance by reagent and titrant
- Deficit of absorbance by product only

UNIT-4

1. Conductometry [9 hours]

- Electric transport, Ohms law, resistance in metals and in electrolyte solution

conductance, specific resistance, specific conductance, equivalent conductance, Molecular conductance in electrolyte solution,

- Importance of conductivity electrodes and platinization of electrodes etc.
- Effect of dilution on different type of conductance
- Introduction to conductivity cell, different types of conductivity cells

area of cross section of dip type electrode and distance between two plates of electrodesetc.

- Kohlrausch law and its importance,
- cell constant and its importance.
- Importance of conductivity water and temperature for the measurement of conductivity

- **<u>Conductometry Titrations:</u>**
  - (1) Strong acid - strong base
  - (2) Strong acid - Weak base
  - (3) Weak acid – Strong base
  - (4) Mixture of (strong acid + Weak acid) versus strong base / weak base
- **<u>Precipitation Titration:</u>**

  (1) $AgNO_3$ – NaCl (2) $BaCl_2$ – K_2SO_4 (3) $Ba(OH)_2$ – $MgSO_4$
- **<u>Replacement Titration:</u>**
  - (1) Salt of weak acid – strong acid
  - (2) Salt of weak base – strong base

❖ **<u>Applications of conductometry titrations:-</u>**

- To determine degree or hydrolysis and hydrolysis constant
- To determine degree of dissociation and dissociation constant
- To determine solubility and solubility product of sparingly soluble salt

2. Introduction of complexometry titration [3 hours]

- Introduction to different terms related to complexometry titrations; like complex, chelate, legand, different type of valency of metal ion, coordination number etc.
- Method of preparation of standard EDTA solution
- Velcher's law explanation, Graph of "pM versus volume of EDTA", stability constant value.
- Different types of EDTA titration e.g. (i) Direct titration, (ii) Back titration, (iii) Replacement titration (iv) Alklimetry titration
- Masking and demasking
- Principle of metal ion indicator,
- Brief introduction to metal-ion indicators with structure and characteristics; e.g. EBT, calcon, muroxide.

UNIT-5

1. Volumetric analysis with example of calculation based on pH, normality, molarity, Ksp etc. [12 hours]

- Ostwald's law- Regarding indicator – necessary derivation and formula of indicator used in Neutralization, redox, precipitation titration.
- Primary and secondary standard explanation

Explanation of neutralization titration with graph

- Strong acid - Strong base titration
- Weak acid - Strong base titration
- Strong acid – Weak base titration
- Poly protic acid - Strong base titration

Redox Titration

- Principle of external and internal indicator in redox titration. e.g. Diphenyl amine, starch & $K_3[Fe(CN)_6]$
- Redox Titration with graph and calculation
- Iodometry and Iodimetry titration
- Preparation of standard sodium thiosulphate solution

Precipitation Titration

- Argentometric Titration (I) Mohr's method (II) Fazan's method (III) Volhard's method with use of proper indicator, graph and its practical application
- Examples of calculation based on pH, Normality, Molarity, Ksp etc...

Saurashtra University

B.Sc. SEMESTER – V

CHEMISTRY PRACTICALS [C-504] SYLLABUS

[Practical Exam. would be conducted for 1 ½ days]

[Total Marks: 105 marks]

EFFECTIVE FROM JUNE-2021

1. **Organic Separation (Mixture of two compounds) [30 marks]**
   [Minimum 12 mixtures should be done]

   Separation & Analysis of an organic mixture containing

   (a) Two solid components using water, $NaHCO_3$, NaOH and HCl for separation

   (b) Liquid + liquid component - separation by physical method.

   (c) Liquid + solid component - separation by physical method.

2. **Inorganic Volumetric Analysis [30 marks]**

   [Minimum 8 exercises should be done]

   For volumetric exercise all the standard solutions are to be prepared by the students.

   i. Iodometry and Iodimetry

   (a) Estimation of Cu^{+2} and $CuSO_4.5H_2O$ in the given $CuSO_4.5H_2O$ using 0.05N $Na_2S_2O_3.5H_2O$ solution.

   (b) Estimation of As^{+3} and As_2O_3 in the given As_2O_3 using 0.05N $Na_2S_2O_3.5H_2O$ solution.

   ii. Complexometric titration:

   1. Estimation of the amount of Ni^{+2} in the given $NiSO_4.7H_2O$ solution using 0.02 N EDTA solutions.
   2. Estimation of the amount of Mg^{+2} and Pb^{+2} in the given solution containing a mixture of Mg^{+2} and Pb^{+2} using 0.02 N EDTA solution
   3. Estimation of the amount of Ca^{+2} and Zn^{+2} in the given solution containing a mixture of Ca^{+2} and Zn^{+2} using 0.02 N EDTA solution
   4. Estimation of the amount of Fe^{+3} and Cr^{+3} in the given solution containing a mixture of Fe^{+3} and Cr^{+3} using 0.02 N/ 0.01 M $Pb(NO_3)_2$ and 0.02 N/ M EDTA solution.

iii. Redox titration

1. Determination of the amount of NO_2^{-1} in the given $NaNO_2$ or KNO_2 solution by reduction method using 0.1 N $KMnO_4$ solutions.

iv. Water Analysis

1. To determine the amount of chloride in the given sample of water using N $AgNO_3$

v. To determine the purity of $NaHCO_3$ in the given sample

3. Physicochemical Exercise [30 marks]

[Minimum 10 exercises should be done]

1. Conductometry

i. To determine normality and gms/lit of xNHCl and also determine specific conductance by conductometry.

ii. To determine normality and gms/lit of the mixture of HCl+CH_3COOH by conductometry.

iii. To determine the normality of weak acid by conductometry

iv. To determine the concentration of Ni+2 using 0.1M EDTA solution.

v. To determine the normality of x$NAgNO_3$ using 0.5N NaCl b y Conductometry.

2. Thermodynamics:

i. Calculate entropy of vaporization (ΔS_v) of a given liquid by plotting a graph of log (1/time) vs (1/temperature)

3. Refractometer

i. To determine specific refractivity and molecular refractivity of given pure liquid A, B, C, D.

ii. To determine specific refractivity and molecular refractivity of glycerine (10%, 5%, 2.5%) and unknown glycerine solution.

4. Viscosity

i. To determine relative and absolute viscosity of pure liquid A, B, C, D by Ostwald's viscometer.

ii. Preparation three different 10%, 5%, 2.5% aqueous solution of glycerine, find viscosity of these three solutions as well as unknown concentration solution with the help Ostwald's viscometer.

5. Colourimetry

i. Find out the amount of Ni^{+2} in the given solution by colourimetry method.

ii. Find out the amount of Fe^{+3} in the given solution by colourimetry method.

6. Polarimeter

i. To determine specific rotation of three different concentration (10%, 5%, 2.5%) of dextrose solution. From graph find out the unknown.

ii. Study the inversion rate of sugar in presence of 1N HCl and determine the rate of reaction.

4. Viva-voce; **[15 marks]**

- Organic Separation: **5 marks**
- Inorganic Volumetric Analysis: **5 marks**
- Physicochemical Exercise: **5 mar**