



VIJAYANAGARA
SRI KRISHNADEVARAYA UNIVERSITY,
BALLARI

Ph. D. Entrance Examination Syllabus

(2021-2022)

DEPARTMENT OF INDUSTRIAL CHEMISTRY

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DEPARTMENT OF INDUSTRIAL CHEMISTRY

Syllabus for Entrance examination of Ph.D. degree

Note: The entrance examination is of 3 hours duration and consists of 100 marks. Out of 100 marks **60 marks are from the Chemistry core subject syllabus** and **40 % marks from the Research Methodology syllabus**. The questions are of multiple choice type. Marks distribution for each unit is mentioned at the right side after the end of each unit.

Research Methodology (4 Units- Total 40 Marks)

UNIT 1

Introduction to Research

Nature and importance of research - aims, objective, principles and problems; types of research, Selection of research problems and literature survey: primary sources- Journals periodicals, abstracts; Secondary listing of titles, reviews –annual Treatises, serials, monographs and text books, encyclopedia, catalogues, index of tabulated data. Research ethics.

(10 Marks)

UNIT 2

Research sources and copyright

Science citation index- Searching the chemical literature-location of journal article- materials on a given topic- information about specific compound- Choosing a problem-abstract of a research paper. Internet: Introduction to internet-web browsers-World Wide Web-Search engines-literature survey in Chemistry-popular website in chemistry-Database in chemistry. Scientific ethics and its importance; Plagiarism, Protection of research data. Patent: Introduction, patentable subject; Copyright.

(10 Marks)

UNIT 3

Research sources and data presentation

usage of packages (e.g. ORIGIN; EXCEL) for data analysis; basics of computer operations; using windows – directory structures – command structure (document preparation, EXCEL, Power Point Presentation); E-Mail: Introduction to e-mail- creating e-mail- Receiving and sending e-mail; Research manuscript preparation Full length research paper, short communication, letters, reviews, popular science articles in magazines, Few case studies with reference to journals and periodicals. Presentation of research papers: Oral and poster presentation in seminars, workshops and conferences etc.. (10 Marks)

UNIT 4

Error analysis and safety requirements

Classification of errors-Accuracy-Precision-Minimization of errors-Significant figures. Statistical treatment of data: Mean and Standard Deviation-distribution of random and normal errors-Reliability of results-Confidence interval-Comparison of mean results students t-

distribution and t-tests-Comparison of precision of two methods, comparison of precision of two methods- Linear regression, regression line, standard deviation, correlation coefficient-Multiple linear regression(one variable with two other variables).

Safety requirements in laboratory and data management; Good laboratory practices

Sampling- Significance, types of sampling and sampling of solid, liquid and gaseous samples

(10 Marks)

Core Subject- (8 Units– Total 60 Marks)

Unit – I

Concepts in Organic chemistry

Chemical bonding and Stereochemistry: Atomic and molecular orbits, concepts of bonding, anti bonding and non bonding molecular orbitals, hybridization – sp, sp^2 & sp^3 , geometry and shape of simple molecules, bond length, bond angle and bond energies. Bonding in fullerenes, H-bonding. Bond polarity, dipole moment.

Aromaticity: in benzenoid and non benzenoid compounds, Huckl's rule, annulenes. Aromaticity, antiaromaticity, nonaromaticity of organic systems(3-7 numbered rings & ring ions).

Stereo Chemistry: Elements of symmetry, concepts of chirality, optical isomerism, projection formulae, Fisher, Saw horse, Newman and Flying wedge formulae and their inter conversion, optical isomerism due to one or more than one chiral centres.

Threo and erythro isomer, enantiomers, diastereic isomers and epimers. D-L and R-S conversions. Geometrical isomerism – cis-trans, syn-anti and E-Z nomenclature, isomerism in ketoximes and aldoximes, Beckmann rearrangement.

Reaction Mechanisms, Reactive Intermediates & Named reactions:

Types of mechanism, methods of determination of reaction mechanism – cross over experiments, product analysis, presences of intermediates. Formation, structure and stability of carbocations, carboanions, free radicals, carbenes, nitrenes and aryne intermediates. [8 Marks]

UNIT 2

Coordination and Organometallic chemistry

Geometry, Magnetic and Spectral Properties of Metal Complexes:

Geometry of Metal Complexes: Stereochemistry, coordination numbers, 3 to 8, isomerism in metal complexes, geometrical isomerism, optical isomerism, coordination isomerism, ionization isomerism, linkages isomerism.

Magnetic Properties of Metal Complexes: Magnetic susceptibility, types of magnetic behavior, diamagnetic corrections, orbital contribution, spin-orbit coupling, ferro and anti-ferromagnetism.

Organometallic Chemistry: Classification & nomenclature of organometallic compounds – 16 & 18 electron rules – electron counting by neutral atom & oxidation state method.

Transition metal alkyls (synthesis and stability), metal carbonyls, nitrosyls, carbenes (Fischer and Shock) synthesis and bonding. (10 Marks)

UNIT 3

Thermodynamics and electrochemistry

Chemical Thermodynamics:

A brief resume of laws of thermodynamics (combined form of 1st and 2nd laws), entropy as a measure of unavailable energy, concept of fugacity and free energy. Variation of free energy with T & P. Maxwell's relations. Third law of thermodynamics- free energy of mixing, partial molar quantities, partial molar volume and free energy (chemical potential). Gibbs- Duhem and Duham-Margules equations.

Chemical Kinetics: definition of rate, order and molecularity. Half-life period, theory of reaction rates

Electrochemistry of Solutions:

Electrical double layer and its thermodynamics. A brief survey of Helmholtz – Perrin, Gouy – Champman and Stern electrical double layer, EMF cells, liquid junction potential and its determination. Energetics of cell reactions, effect of temperature, pressure and concentration on energetics of cell reactions

Electrochemical energy sources – Batteries, classification, characteristics, primary, secondary and Fuel cells. [10 Marks]

UNIT 4

Analytical Chemistry

Acid base titrations: Principle, titration curves; equivalence point – theory acid base indicators applications.

Complexometric Titrations: Introduction, a simple complexation titration, selectivity, masking and demasking agents, metal ion indicators, some practical considerations.

Oxidation –Reduction Titrations: Redox process, titration curves, redox indicators and applications.

Separation techniques: Introduction, basics to separation and chromatographic techniques; classification of chromatographic techniques.

Paper and thin layer Chromatography: General principles and classification of chromatographic methods-paper, thin layer, column and liquid chromatography.

Ion Exchange Chromatography: Definitions, requirements for ion exchange resin, types of ion exchange resins, principle, ion exchange capacity, applications of ion exchange chromatography.

Gas Liquid Chromatography: Principle, apparatus-columns, detectors, applications.

HPLC Principles: Instrumentation-columns, stationary phase and matrices, applications.

Thermal Methods of Analysis: Principle, working and applications of TGA, DSC and DTA [10 Marks]

UNIT 5

Spectroscopic Techniques

Electromagnetic radiation: regions of electromagnetic radiation spectrum – interaction electromagnetic radiation with matter

UV-Visible Spectroscopy: Quantitative aspects of absorption – Beer- Lambert's law. Criteria for spectrophotometric determinations with examples (Fe, Mo and Ni). Limitations of the law, Types

of absorption bands, simplechromophoric –auxochrome theory. Wood-Ward and Fischer rules for conjugated dienes, trienes, Quantitative applications.

Infra Red Spectroscopy: Introduction – Molecular vibrations –, calculation of vibrational frequencies, instrumentation-- FT – IR Spectrometer. Sampling techniques, interpretation of IR spectra, important regions in the IR spectrum; applications of IR spectroscopy in the structural elucidation of organic compounds.

HNMR Spectroscopy: Introduction – Nuclear spin and magnetic moment, origin of NMR spectra, interpretation of NMR spectrum, chemical shifts(down field and up field), factors influencing chemical shifts, spin-spin relaxations, use of HNMR spectrum in structural elucidation.

Mass Spectroscopy: Introduction – Basic theory, types of ions, factors affecting fragmentation, McLafferty rearrangement, nitrogen rule, applications of mass spectrometry.

[10 Marks]

UNIT 6

Unit V: Adhesives and Explosives

Adhesives:

Introduction, theories of adhesion, advantages and disadvantages of using adhesives, chemistry and uses of adhesives, natural product based adhesives, pressure sensitive adhesives, hot melt adhesives, solvent and emulsion based adhesives. Explosives:

Classification, characteristics, preparation of explosives, nitro cellulose, TNT, Dynamite, Cardite, Gun Powder, Lead azide and RDX. [8 Marks]

UNIT-7

Unit Processes: Extraction, Evaporation, and Drying

Extractions:

Liquid equilibria, Extraction with reflux, Extraction with agitation equipment, its use and performance, continuous contact equipment, agitator extractors, packed spray extractors, Leaching, flow sheets of solid-liquid extraction, continuous leaching, counter current extraction Evaporation;Types of evaporators, jacketed, horizontal and vertical tube evaporators, forced circulation evaporations, entrainment separators (upturned, deflector type, tangential type), effect of scale formation, multiple effect evaporators

Drying:

General Principles (Significance, moisture content), Rate of drying (Constant & falling rate period, factors affecting drying), Drying equipments, Tray dryers, Rotary dryers, Single Drum dryer & Spray dryers. (8 Marks)

UNIT 8

Polymers and Nanoscience

Importance of polymers. Basic Concepts:

Monomers, degree of polymerization..Classification of polymers. Polymerization: Condensation, addition, radical chain-ionic and co-ordination and co-polymerization

. **Polydispersion-average molecular weight concept:** Number, weight and viscosity average molecular weights, practical significance of molecular weight. Measurement of molecular weights.

Morphology and order in crystalline polymers - configurations of polymer chains. Crystal structures of polymers. Morphology of crystalline polymers. Polymer structure and physical properties-crystalline melting point T_m -melting points of homogenous series, The glass transition temperature.

Polymer processing: Plastics, elastomers and fibres, compounding. Processing techniques.

Electrically conducting polymers and Biomedical polymers: Properties and applications.

Chemistry of nanomaterials :Introduction: Synthesis, properties and Scope and importance of nanoscience and nanotechnology. [10 Marks]