

**SYLLABUS FOR Ph.D. ENTRANCE EXAMINATION,
AS PER Ph.D. 2024 REGULATIONS
SUBJECT: CHEMISTRY**

The syllabus has two parts, **Part-A (Research methodology) 3 units and Part-B
(Chemistry) 7 units**

PART-A: RESEARCH METHODOLOGY

UNIT-I

Research: Meaning – Purpose- Types of research-significance of research in chemical sciences.

Characteristics of Research and Research Worker. Classification of Research in relation to Nature and Methods. Research Ethics.

Steps in Research: Identification, selection and formulation of research problem Research objectives-Research design- Hypothesis-Significance, Formulation and Types.

Review of literature. Reasons for surveying related literature, Allied and critical Literature.

UNIT-II

Experimental Research. Meaning and Nature of Experimental Research. Sources of Experimental Invalidity. Experimental Designs: Pre, True and Quasi Experimental designs.

Sampling Technique: Sampling theory-Types of sampling-Steps in sampling, sampling and Non-sampling error-Sample size –Advantages and limitations of sampling.

Data for Research: Primary data-Meaning-Collection methods-Observation – Interview- Questionnaire-Schedule-Pretest-Pilot study –Experimental and case studies- Secondary data-Meaning – Relevance, limitations and cautions. Online databases.

UNIT-III

Processing Data: Checking- Editing-Coding- transcriptions and Tabulation- Data analysis-Meaning and methods- Quantitative and Qualitative analysis.

Structuring the Report: Chapter format- Pagination- Identification- Using quotations- Presenting footnotes – abbreviations- Presentation of tables and figures- Referencing- Documentation-Use and format of appendices- Indexing.

Research Report: Types of reports-Contents-Styles of reporting- Steps in drafting reports- Editing the final draft-Evaluating the final draft. Preparation of Research proposal. Referencing in academic writing.


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PART- B: CHEMISTRY

UNIT-IV

Chemical periodicity, Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory).

Concepts of acids and bases, Arrhenius Theory, Lewis, Brønsted-Lowry, Lux-Flood, Usanovich and Solvent system concepts. Leveling effect. Hard-Soft acid base concept, Non-aqueous solvents.

Main group elements and their compounds: Allotropy, synthesis, structure and bonding, industrial importance of the compounds.

Transition elements and coordination compounds: Structure, bonding theories, spectral and magnetic properties, reaction mechanisms.

Inner transition elements: Spectral and magnetic properties, redox chemistry, analytical applications.

UNIT-V

Symmetry and Group theory: Symmetry elements and symmetry operations, point groups. Schönflies notation. Assignment of molecular point group. Character tables; Selection rules.

Organometallic compounds: Synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis. Cages and metal clusters.

Bioinorganic chemistry: Bioinorganic aspects of Na, K, Ca and Mg. photosystems, porphyrins, metalloenzymes, oxygen transport, electron- transfer reactions; nitrogen fixation, metal complexes in medicine. Metal ion deficiency and treatment.

Nuclear chemistry: Nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

UNIT-VI

Basic principles of quantum mechanics: Postulates; operator algebra; exactly- solvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; orbital and spin angular momenta; tunnelling.

Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications.

Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes; Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions.

UNIT-VII

Statistical thermodynamics: Different statistical distributions; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems.

Electrochemistry: Nernst equation, redox systems, electrochemical cells; Debye- Huckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations.

Chemical kinetics: Empirical rate laws and temperature dependence; complex reactions; steady state approximation; determination of reaction mechanisms; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical reactions.

Colloids and surfaces: Stability and properties of colloids; different adsorption isotherms-their limitations and applications; heterogeneous catalysis.

Solid state: Crystal systems and Bravais Lattice. Crystal structures; Bragg's law and applications; Theory of X-ray diffraction; Miller indices and planes. Point group and space groups. Band structure of solids.

Polymer chemistry: Classification of polymers; Different Molecular weights; kinetics of polymerization; Methods of synthesis; Applications.

UNIT-VIII

Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction.

Aromaticity: Benzenoid and non-benzenoid compounds – generation and reactions.

Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzyne and nitrenes.

Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways.

Common named reactions and rearrangements – applications in organic synthesis.

UNIT-IX

Organic transformations and reagents: Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Chemo, regio and stereoselective transformations.

Pericyclic reactions – electrocycloisatation, cycloaddition, sigmatropic rearrangements and other related concerted reactions. Principles and applications of photochemical reactions in organic chemistry.

Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S).

UNIT-X

Data analysis: Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient.

Analytical chemistry- Separation, spectroscopic, electro- and thermoanalytical methods.

Characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques.

Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; basic principles of magnetic resonance.

Structure determination of organic compounds by IR, UV-Vis, ^1H & ^{13}C NMR and Mass spectroscopic techniques.

Reference Books

- Kothari C.R., Research Methodology Methods and techniques by, New Age International Publishers, 2nd
- Donald H. McBurney, Research Methods, 5th Edition, Thomson Learning, ISBN:81-315-0047-0, 2006.
- Fundamental of Analytical Chemistry, D.A. Skoog, D.M West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
- Analytical Chemistry, G.D Christian, 5th edition, 2001 John Wiley & Sons, Inc, India.
- Quantitative Analysis, R.A Day and A.L. Underwood, 6th edition, 1993prentice Hall, Inc. New Delhi.
- Vogel's Text book of Quantitative Chemical Analysis, J. Mendham, R.C Denney, J.D Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint.2003 Pearson education Pvt. Ltd., New Delhi.
- Analytical Chemistry Principals, John H. Kennedy, 2nd edition, Saunders College Publishing California, 1990.
- Inorganic Chemistry (4th edition): J.E Huheey, E.A Keiter and R.L. Keiter (1993); Harper Collins.
- Introduction to modern inorganic chemistry (4thedition): K.M. Mackay and R.A Mackay (1989); Blackie.
- Advanced inorganic Chemistry (5th edition): F.A Cotton and G.Wilkinson (1990): Wiley.
- Concise Inorganic Chemistry (5th edition): J.D. Lee (2000); Blackwell Science.
- Concepts and Models if Inorganic Chemistry (3rd edition) B.E.Dougglas, D.H. Mc Daniel and Alexander. (2001): Wiley.
- Chemistry of the Elements: Greenwood and Earnshaw. (1986): Pergamon Press.

- Inorganic Chemistry (3rd edition): Shriver, Atkins and Langford (1999); Oxford University Press.
- E.L.Eliel and S.H. Wilen, Stereochemistry of Organic Compounds, JhonWiley and Sons, New York. 1994.
- Introduction to stereo chemistry- K.Mislow.
- Stereo chemistry and mechanism through solved problems – P.S. Kalsi.
- D. Nasipuri, Stereo chemistry of Organic Compounds, 2nd edition, Wiley Eastern Limited, New Delhi, 1987.
- H.Pine, Hendrickson, Cram and Hammond, Organic Chemistry, Mac Grow hill, New York, 1987.
- Organic Chemistry – Morrison & Boyd.
- I.L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.
- Basic principles of Organic Chemistry – Robert & Casereo.
- N.S. Issacs, Reactive intermediates in Organic Chemistry, John Willey abd Sons, New York. 1974.
- R.K. Bansal, Organic Reaction Mechanism, Wiley Eastern Limited, New Delhi, 1993.
- J. March, Advanced Organic Chemistry Wintermediates in Organic Chemistry Wirley Interscience, 194.
- E.S. Gould, Mechanism Mechanism and Structure in Organic Chemistry, Halt, Rinhart and Winston, New York, 964.
- A guide book to mechanism in Organic Chemistry – Petersykes.
- F.A Carey and Sundberg, Advanced Organic Chemistry – Part A & B, 3rd edition, Plenum Press, New York, 1990.
- S.K. Ghosh, Advanced General Organic Chemistry, Book and Alleied (P) Ltd, 1998
- Quantum Chemistry - A. K. Chandra, Second Edition, Tata McGraw Hill Publishing Co. Ltd., (1983).
- Quantum Chemistry – Eyring, Walter and Kimball, John Wiley and Sons, Inc., New York.
- Quantum Chemistry – I.N. Levine, Pearson Education, New Delhi, (2000).
- Theoretical Chemistry – S. Glasstone, East West Press, New Delhi, (1973).
- Quantum Chemistry- R.J.Prasad, New Age International Publishers (1996).
- Valence Theory – Tedder, Murel and Kettle.
- Quantum Chemistry- D.A. McQuarrie.
- Theoretical Inorganic Chemistry – Day and Selbin.
- Elements of Physical Chemistry – Lewis and Glasstone.
- Physical Chemistry by P.W. Atkins, ELBS, 4th Edition, Oxford University Press (1990)
- Introduction to electrochemistry by S. Glasstone.
- Modern Electrochemistry Vol I and II by J.O.M. Bockr's and A.K.N. Reddy, Plenum Press, New York (1970).
- Chemical and Electrochemical energy systems – R.Narayanand B. Vishwanathan, Universities Press (India) (1998).
- Electrochemistry – Principles and applications by E.G. Potter.
- Electrochemistry by Reiger, Prince Hall (1987).

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