

## RESEARCH METHODOLOGY

**Nature and Purpose of Research:** Meaning of research, aim, Nature and scope of research, Prerequisites of research, Types of research: Exploratory, Descriptive and Experimental.

**Research Problem:** Types of research problems, Characteristics of a good research problem, Hypothesis: Meaning and types of hypothesis, Research proposal or synopsis.

**Research Methods:** Qualitative and Quantitative

**Review of Literature:** Purpose of the review, Identification of the literature, organizing the literature.

**Data Collection and Analysis:** Types of data, Methods of data collection, Sample and Population, Sampling Techniques, Characteristics of a good sample, Tools of Data Collection: Observation method, Interview, Questionnaire, various rating scales, Characteristics of good research tools.

**Descriptive Statistics:** Tabulation, Organization, and Tabulation and Graphical Representation of Quantitative data, Measures of Central Tendencies: Mean, Median, Mode Measures of Variability: Range, Quartile Deviation, Standard Deviation, and Coefficient of variation. Normal Probability Distribution: Properties of normal probability curve, Skewness and Kurtosis, Data analysis with Statistical Packages (MS-Excel, SPSS), Hypothesis Testing, Generalization and Interpretation.

**Research Report:** Structure and Components of Research Report, Types of Report, Characteristics of Good Research Report, Bibliographical Entries, Research Ethics

## APPLIED CHEMISTRY

### Inorganic Chemistry

1. Chemical periodicity
2. Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory).
3. Concepts of acids and bases. Hard-Soft acid base concept. Non-aqueous solvents.
4. **Main group elements and their compounds:** Allotropy, synthesis, structure and bonding, industrial importance of the compounds.
5. **Transition elements and coordination compounds:** structure, bonding theories. Spectral and magnetic properties, reaction mechanisms.
6. **Inner transition elements:** spectral and magnetic properties, redox chemistry, analytical applications.
7. **Organometallic compounds:** synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis.
8. **Cages and Meta clusters.**
9. **Analytical chemistry-** separation, spectroscopic, electro- and thermoanalytical methods.
10. **Bioinorganic chemistry:** photosystems, porphyrins, metalloenzymes, oxygen transport, electron- transfer reactions; nitrogen fixation, metal complexes in medicine.
11. **Characterisation of inorganic compounds by IR.** Raman, NMR. EPR, Mossbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques.
12. **Nuclear chemistry:** nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis. .

### Physical Chemistry:

1. **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; tunneling.
2. **Approximate methods of quantum mechanics:** Variational principle; perturbation theory up to second order in energy; applications.
3. **Atomic structure and spectroscopy:** term symbols: many-electron systems and antisymmetry principle.
4. **Organic reactive intermediates:** Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzyne and nitrenes.
5. **Organic reaction mechanisms** involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways.
6. **Common named reactions and rearrangements-** applications in organic synthesis.

7. **Organic transformations and reagents:** Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Chemo, region and stereoselective transformations.
8. **Concepts in organic synthesis:** Retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.
9. **Asymmetric synthesis:** Chiral auxiliaries, methods of asymmetric induction- substrate, reagent and catalyst controlled reactions; determination of enantiomeric and diastereomeric excess; enantio-discrimination. Resolution- optical and kinetic.
10. **Pericyclic reactions-** electrocycloisatation, cycloaddition, sigmatropic rearrangements and other related concerted reactions. Principles and applications of photochemical reactions in organic chemistry.
11. Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S).
12. Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids.
13. Structure determination of organic compounds by IR. UV-vis,  $^1\text{H}$  &  $^{13}\text{C}$  NMR and Mass spectroscopic techniques.