RAJ RISHI BHARTRIHARI MATSYA UNIVERSITY, ALWAR

PRE PH.D. ENTRANCE TEST (PET) 2017- SYLLABUS

SUBJECT- CHEMISTRY

INORGANIC CHEMISTRY

1. **Main group elements and their compounds**: Allotropy, synthesis, structure and bonding. boranes. carboranes, silicones, silicates, boron nitride.
2. **Concepts of acids and bases**: Hard-Soft acid base concept. Non-aqueous solvents
3. **Inner transition elements**: Spectral and magnetic properties, redox chemistry, analytical applications.
4. **Organometallic compounds**: Synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis
5. **Bioinorganic chemistry**: Photosystems, porphyrins, metalloenzymes, oxygen transport, electron-transfer reactions; nitrogen fixation, metal complexes in medicine.
6. **Chemistry of coordination compounds:** Theories of bonding, crystal field theory, limitations of crystal field theory, ligand field theory- orbital splitting in octahedral, tetrahedral and square planar complexes. ligand field stabilisation energy, π-bonding, John-Teller effect, spectral and magnetic properties, reaction mechanisms.
7. **Cages and metal clusters**.
8. **Analytical chemistry**: Separation, spectroscopic, electro- and thermoanalytical methods.
9. **Characterisation of inorganic compounds** by IR, Raman, NMR, EPR, Mossbauer, UV-VIS, NQR, MS, electron spectroscopy and microscopic techniques.
10. **Nuclear chemistry**: Nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

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ORGANIC CHEMISTRY

1. **Nature of bonding in Organic Molecules**: Localised and delocalised covalent bond, Concept of aromaticity, annulenes and hetero annulenes, inductive and mesomeric effects, Huckel's rule for aromaticity in benzenoid and non-benzenoid compounds, anti-aromaticity and homo-aromaticity. Introduction to types of organic reactions reactive intermediates.
2. **Stereochemistry and stereoisomerism:** Conformational isomerism and analysis in acyclic and simple cyclic systems - substituted ethanes, cyclohexane, optical isomerism - optical activity -molecular dissymmetry and chirality. R-S configurations - relative and absolute configurations optical isomerism due to asymmetric carbon atoms - optical isomerism, geometrical isomerism and E-Z configurations, properties of geometrical isomers. R-S nomenclature, diastereo isomerism in acylic and cyclic systems inter conversions of Fisher, Newman and Saw-horse projections.
3. **Name Reactions:** Basic concepts of some named and unnamed reactions: Aldol, Perkin, Benzoin. Stobbe, Cannizaro, Wittig, Grignard, Openauer oxidation, Clemmensen reduction, Meerwein – Pondorf Verley reduction, Birch reduction, Michael addition, Mannich Reaction, Diels - Alder reaction, Wolf-Kishner reduction, Friedel – Crafts reactions, Robinson annulation.
4. **Rearrangements:** Classification and general mechanistic treatment of nucleophilic, free radical and electrophilic rearrangements, Wagner – Meerwein and related reactions, Hofmann, Stevens and Wittig rearrangements
5. **Natural Products:** Isolation, structure elucidation and synthesis of alkaloids; atropine, caffeine. terpenoids: α- terpeneol, camphor.
6. **Aliphatic and Aromatic Substitution Reactions: Nucleophilic** : The SN^2, SN^1, SN^i and SET mechanisms, neighbouring group participation (anchimeric assistance), classical and non classical carbocations, phenonium ions, norbornyl system allylic, aliphatic trigonal and vinylic carbon, factors effecting substitutions.
7. **Electrophilic:** SE^1, SE^2 and SE^i Mechanisms and related effects.
8. **Elimination Reactions:** The E^2, $E^1$and E^1_{cB} mechanisms and their orientation of the double bond. Reactivity-effects of substrate structure, attacking base, leaving group and the medium. Stereochemistry of eliminations in acyclic and cyclic systems, orientation in eliminations – Saytzeff and Hoffman elimination.
9. **Addition Mechanisms**: Addition to carbon multiple bonds. Addition reactions involving electrophiles. nucleophiles and free radicals, cyclic mechanisms, orientation and stereochemistry.
10. **Chemistry of Heterocyclic compounds**: Synthesis and Reactivity of the following system, Pyrrole. Furan, Thiophene, Pyridine, Quinoline, Indole, Benzofuran, Pyrazole, Imidazole, Oxazole, Thiazole. Pyridazine, Pyrimidine.

11. **Spectra and structure:** Introduction to application of spectroscopic methods for understanding the structure of simple organic molecules: UV, IR and NMR techniques

PHYSICAL CHEMISTRY

1. **Quantum Chemistry**: Wave equation-interpretation of wave function-properties of wave function-normalization and orthogonalisation, operators-linear and non linear commutators of operators. Postulates of quantum mechanics, setting up of operators observables- Hermitian operator- Eigen values of Hermitian operator. Particle in one dimensional box, particle in a three dimensional box, rigid rotor
2. **Chemical bonding in diatomics**: Elementary concepts of MO and VB theories; Huckel theory for conjugated π-electron systems.
3. **Chemical Kinetics**: Theories of reaction rates- Collision theory of reaction rates, steric factor. Theory of absolute reaction rates, comparison of results with Eyring and Arrhenius equations; unimolecular reactions and RRKM theory. Reactions in solution- primary and secondary salt effects, effect of dielectric constant. Homogeneous catalysis-acid-base catalysis- protolytic and prototropic mechanism; Enzyme catalysis- Michaelis-Menten kinetics. Heterogeneous catalysis- Langmuir adsorption isotherm.
4. **Electrochemistry**: Nernst equation, redox systems, electrochemical cells. Debye-Huckel theory. Electrolytic conductance – Kohlrausch's law and its applications, ionic equilibria, conductometric and potentiometric titrations.
5. **Photochemistry**: Photophysical and photochemical processes- Jablonski diagram—radiative and radiationless transitions-internal conversion and inter system crossing- fluorescence and phosphorescence- Quantum yield and determination-photochemical reactions with high and low quantum yields with examples; sensitization and quenching-derivation of Stern-Volmer equation
6. **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.
7. **Statistical thermodynamics**: Boltzmann distribution law, kinetic theory of gases, partition functions and their relation to thermodynamic quantities – calculations for model systems.
8. **Symmetry and Group Theory**: Chemical applications of group theory, symmetry elements, point groups, character tables, selection rules.
9. **Molecular spectroscopy**: Rotational and vibrational spectra of diatomic molecules, electronic spectra, IR and Raman activities – selection rules, basic principles of magnetic resonance.
10. **Solid state**: Crystal structures, Bragg's law and applications; band structure of solids.
11. **Polymer chemistry**: Molar masses, kinetics of polymerization.

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