Guidelines Governing the Entrance Test for Admission in the Research Programme of the University

Applicants fulfilling the eligibility criteria a in Regulations 1(a) or 1(b) and not covered under 1(c) and seeking admission to the Ph.D programme of the university shall be required to take a qualifying examination to be conducted in the beginning of each academic year. The purpose of the qualifying examination is to identify those candidates who are qualified and have the aptitude to work towards the Ph.D degree. The examination shall test the basic competency of the applicant across a broad range of relevant topics. A candidate must submit the application in a prescribed format (Appendix – H) to register himself/herself with the respective Dean of the Faculty to take this examination at least three weeks prior to the commencement of the examination. The candidate found eligible to take the examination shall be issued the 'Admit Card' by the Dean's office.

The qualifying examination shall be of three hours duration carrying 100 marks and shall consist of the questions categorized into the following three areas (**Group A, Group B, and Group C**) in which relevant topics shall be identified as under:

Group A – shall carry 20 marks and 5 questions, each carrying 4 marks, shall be set from the topics as under to test the communicative skill and analytical ability of the candidate Research methodology, types of research (descriptive, exploratory, explanatory, basic, applied, experimental, evaluation, etc), methods of research (field study method, experimental method, survey method, case study method, statistical method, etc), hypothesis, definition and types.

Group B – shall carry 60 marks and 15 short answer type questions, each carrying 4 marks, shall be set from the topics contained in **core papers (compulsory papers)** of the concerned Master's level courses of the University.

Group C – shall carry 20 marks and in this group a candidate shall be asked to write a proposal of research on the topic suggested therein highlighting its relevance to the present day society.

The Deans of the Faculties in consultation with the Heads of the University Departments shall undertake the responsibility for the questions setting, evaluation and publication of the results of the qualifying examination. The concerned Dean shall notify the result to each examinee. Upon getting the pass result, a candidate shall be required to apply for the registration as per the Ph.D regulations of the University.

Chemistry

Time: 3 hrs Syllabus for Ph.D Entrance Examination Full Marks: 100

Group : A (Objective)

Twenty questions are to be set; Ten are to be answered (4×10 = 40)

Full Marks : 40

1. Physical

(a) Mole concept, Strength of Solutions, Chemical equivalent, Chemical calculations related to volumetric and gravimetric analysis, Chemical equilibrium, Calculation of molecular weight of (a) Acid (b) Base (c) Electrolyte and Non- electrolyte using colligative properties.

(b) Ionic Equilibrium, Solubility Product, Common ion effect, pH of (a) Buffer Solution (b) Aqueous solution of salt, Acids and Bases, HSAB concepts.

(c) Balancing of Redox reactions.

(d) Kinds of reversible electrolytes, calculation of E.M.F. of cell; concentration cell (a) with and (b) without transport.

(e) Distribution Law: Solvent extraction (a) in one lot (b) in several lot; Phase component, degree of freedom, eutectic Point, azeotropic mixture, critical solution temperature

(f) Concept of path dependent and path independent functions, properties of exact differentials, idea of Gibbs free energy, enthalpy and entropy.

2. Organic

(a) Hybridization, Fission of covalent bond, Polarization of covalent bond: Inductive, Resonance, Hyperconjugation, Electrophile, Nucleophile, Idea of SN_1 and SN_2, E_1 and E_2.

(b) Nomenclature of organic compounds, R, Z and E, Z nomenclature, interconversion of of different projection formula, conformation of disubstituted cyclohexanes and decalins.

(c) Knowledge of reaction intermediates such as carbocations, carbanions, carbon free radicals, carbenes, nitrenes and benzynes.

(d) Methods of investigation of reaction mechanism including isotopic tracer method.

3. Inorganic

(a) Atomic orbitals, electronic configuration of atoms (L-S coupling), Periodic properties of element – Ionic radii, ionization potential, electron affinity, electronegativity

(b) VSEPR theory: Shape/Structure of molecules.

(c) Identification of symmetry elements and point groups in simple molecules.

(d) Types of errors, propagation of errors, accuracy and precision, least square analysis, average standard deviation.

(e) Principle of acid-base, permanganometry, dichromatory and thiosulphate titrations.

(f) Principle of gravimetric analysis of Fe, Cu, Ni, Mg, sulphate and chloride

(g) Principle of qualitative analysis of following in presence of each other (i) Cu^{2+} & Cd^{2+} (ii) Ca^{2+} & Sr^{2+} (iii) Fe^{2+} & Fe^{3+} (iv) PO_4^{3-} & AsO_4^{3-} (v) CO_3^{2-} & SO_3^{2-} (vi) Cl^- , Br^- & I^- (vii) NO_2^- & NO_3^-

GROUP: B

Eighteen questions are to be set out of which twelve questions are to be answered

Marks : 5×12

1. Thermodynamics

Partial molar quantities, excess thermodynamics function, Debye Huckel theory for activity coefficient of electrolyte solution, entropy, residual entropy and third law.

2. Chemical Kinetics

Mechanism of photochemical and thermal chain reactions, collision theory of reaction rates, kinetics of unimolecular reactions, primary and secondary salt effect, kinetics of enzyme reactions, laws of photochemistry, quantum yield, photophysical and photochemical process.

3. Electrochemistry

Debye Huckel – Onsager equation, electrokinetic phenomenon, zeta potential, sedimentation potential and streaming potential.

4. Surface Chemistry

Adsorption and absoption, Freundlich, Langmuir isotherm and BET equation.

5. Quantum Chemistry

Quantum mechanical operators and commutation relation, eigen functions, eigen values, orthonormality, symmetric and antisymmetric wave functions, Particle in one and three dimensional box with infinite potential energy barrier, degeneracy, simple harmonic oscillator (derivation not required), calculation of probability density of a state function whose (a) wave function is Cartesian coordinate dependent & (b) Spherical coordinate dependent.

Energy calculation of molecular orbitals of (a) butadiene (b) cyclopropenyl radical by Huckel molecular orbital method. Calculation of electron density, charge density of each carbons of the above two systems.

6. Bonding and structures of

(a) Boranes, carboranes, borazines, silicates, phosphazines, S-N compounds

(b) Carbonyls, nitrosyls, dinitrogen and π – complexes of olefins and cyclopentadienes with transition metals (spectroscopic evidences also required)

7. General characteristics of transition metal and inner transition metals

8. Coordination Chemistry

(a) VBT (b) CFT – CFSE, Jahn – Teller effect, spectral and magnetic properties of complexes, stability of complexes, nucleophilic substitution reaction in square planar and octahedral complexes, trans effect.

9. Organometallic Chemistry

Oxidative addition, reductive elimination, insertion and deinsertion reaction, hydroformylation of alkenes, hydrogenation of alkenes, Water gas shift reaction, Waker's process, Monsanto process, Ziegler – Natta Polymerization.

10. Photochemistry

Difference between photochemical and thermal reactions, photophysical process, photochemistry of ketones, photoreduction, photolysis Norrish I & II, Paterno – Buchi reaction, photochemistry of 1,3 and 1,4 dienes (both singlet and triplet state) di – π methane rearrangement.

11. Pericyclic Reactions

Concerted and non - concerted reactions, FMO theory of electrocyclic, cycloaddition, sigmatropic and chelotropic reactions, discussion of regiospecificity, stereospecificity of pericyclic reactions with special reference to Diel's Alder reaction, Claisen rearrangement and 1,3 – dipolar addition.

12. Spectroscopy

Problems based on UV, IR, ^{1}H NMR and Mass spectroscopy of organic compounds.

13. Aromaticity, antiaromaticity, nonaromaticity of benzenoid and non – benzenoid compounds, aromaticity and physical properties.

14. Stereochemistry

Chiral and achiral molecules, identification of chiral molecules on the basis of point group consideration, R,S and E, Z – descriptors of chiral molecules having (a) Chiral centre (b) Chiral axis (c) Chiral planes.

Stereochemistry of (i) E_2 reaction (ii) E_1 reaction (iii) SN_1, SN_2 and SN_i reaction, stereochemistry of reduction of C = C by homogeneous and heterogeneous catalysis.

Stereochemistry of the addition of Grignard reagent across C = O in compounds containing one chiral carbon.

15. Reactions by names

Pinacol pinacolone, Favroskii, Bayer – Villiger, Arndt – Eistert, Beckmann, Mannich, Aldol type reaction, Michael, Vilsmeir and Barton reaction

16. Reagents

LDA, LDC, TMSC, TBTH, BF_3, B_2H_6, Wilkinson's reagent, DMSO, NBS, Peracids.

17. Spectroscopy

Rotational spectrum of diatomic molecules, rotational energy, selection rules, population of rotational levels, derivation of junax, calculation of internuclear distance, effect of isotopic substitution, stark effect and its application.

Vibration spectra of harmonic and anharmonic diatomic molecules, Morse function, force constant, interaction of rotation and vibration – different branches.

Polarizability, classical and quantum theory of Raman spectrum, rotational and vibrational Raman spectrum, Mutual exclusion principle.

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