

# NATIONAL INSTITUTE OF TECHNOLOGY MEGHALAYA

## CHEMISTRY DEPARTMENT

### Syllabus for Written Test to 2-Year M.Sc. Programme, June 2017

#### **PHYSICAL CHEMISTRY**

**Atomic and Molecular Structure:** Fundamental particles, Bohr's theory of hydrogen-like atom; wave-particle duality; Uncertainty principle; Schrödinger's wave equation; Quantum numbers, shapes of orbitals; Hund's rule and Pauli's exclusion principle, electronic configuration of simple homonuclear diatomic molecules.

**Theory of Gases:** Equation of state of ideal and non-ideal (van der Waals) gases, Kinetic theory of gases. Maxwell-Boltzmann distribution law; equipartition of energy.

**Solid state:** Crystals, crystal systems, X-rays, NaCl and KCl structures, close packing, atomic and ionic radii, radius ratio rules, lattice energy, Born-Haber cycle, isomorphism, heat capacity of solids.

**Chemical Thermodynamics:** Reversible and irreversible processes; First law and its application to ideal and non-ideal gases; Thermochemistry; Second law; Entropy and free energy, Criteria for spontaneity.

**Chemical and Phase Equilibria:** Law of mass action;  $K_p$ ,  $K_c$ ,  $K_x$  and  $K_n$ ; Effect of temperature on  $K$ ; Ionic equilibria in solutions; pH and buffer solutions; Hydrolysis; Solubility product; Phase equilibria–Phase rule and its application to one-component and two-component systems; Colligative properties.

**Electrochemistry:** Conductance and its applications; Transport number; Galvanic cells; EMF and Free energy; Concentration cells with and without transport; Polarography; Concentration cells with and without transport; Debye-Huckel-Onsager theory of strong electrolytes.

**Chemical Kinetics:** Reactions of various order, Arrhenius equation, Collision theory; Theory of absolute reaction rate; Chain reactions – Normal and branched chain reactions; Enzyme kinetics; photochemical processes; Catalysis.

**Adsorption:** Gibbs adsorption equation, adsorption isotherm, types of adsorption, surface area of adsorbents, surface films on liquids.

#### **ORGANIC CHEMISTRY**

**Basic Concepts in Organic Chemistry and Stereochemistry:** Electronic effect (resonance, inductive, hyperconjugation) and steric effects and its applications (acid/base property). Optical isomerism in compounds without any stereocenters (allenes, biphenyls), conformation of acyclic systems (substituted ethane/n-propane/n-butane) and cyclic systems (mono and di substituted cyclohexanes).

**Organic Reaction Mechanism and Synthetic Applications:** Chemistry reactive intermediates,

carbene, nitrene, benzyne, Hofmann-Curtius-Lossen rearrangement, Wolf rearrangement, Simmons-Smith reaction, Reimer-Tiemann reaction, Michael reaction, Darzens reaction, Wittig reaction, McMurry reaction. Pinacol-pinacolone, Favorskii, benzoic acid rearrangement, dienone-phenol rearrangement, Bayer-Villegier reaction. Oxidation and reduction reactions in organic chemistry. Organometallic reagents in organic synthesis (Grignard and organocopper). Diels-Alder reaction, Sigmatropic reactions.

**Qualitative Organic Analysis:** Functional group interconversions, structural problems using chemical reactions, identification of functional groups by chemical tests, elementary  $^1\text{H}$  NMR and IR spectroscopy as a tool for structural elucidation.

**Natural Products Chemistry:** Introductory chemistry of alkaloids, terpenes, carbohydrates, amino acids, peptides and nucleic acids.

**Heterocyclic Chemistry:** Monocyclic compounds with one hetero atom.

## **INORGANIC CHEMISTRY**

**Periodic Table:** Periodic classification of elements and periodicity in properties; general methods of isolation and purification of elements.

**Chemical Bonding and Shapes of Compounds:** Types of bonding; VSEPR theory and shapes of molecules; hybridization; dipole moment; ionic solids; structure of NaCl, CsCl, diamond and graphite; lattice energy.

**Main Group Elements (s and p blocks):** Chemistry with emphasis on group relationship and gradation in properties; structure of electron deficient compounds of main group elements and application of main group elements.

**Transition Metals (d block):** Characteristics of 3d elements; oxide, hydroxide and salts of first row metals; coordination complexes; VB and Crystal Field theoretical approaches for structure, color and magnetic properties of metal complexes. Organometallic compounds, metal carbonyls, nitrosyls and metallocenes, ligands with back bonding capabilities; MO theory approaches to explain bonding in metal-carbonyl, metal-nitrosyl and metal-phosphine complexes.

**Bioinorganic Chemistry:** Essentials and trace elements of life, basic reactions in the biological systems and the role of metal ions especially  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Cu}^{2+}$  and  $\text{Zn}^{2+}$ , function of hemoglobin and myoglobin.

**Instrumental Methods of Analysis:** Basic principles, instrumentations and simple applications of conductometry, potentiometry, UV-vis spectro-photometry, analysis of water, air and soil samples.

**Analytical Chemistry:** Principles of qualitative and quantitative analysis; acid-base, oxidation-reduction and EDTA and precipitation reactions; use of indicators; use of organic reagents in inorganic analysis; radioactivity; nuclear reactions; applications of isotopes.