INORGANIC CHEMISTRY
SYLLABUS

CHEMISTRY HONS.

DEPARTMENT OF CHEMISTRY
ST. XAVIER'S COLLEGE (AUTONOMOUS)
KOLKATA-700 016

Semester – I

UNIT I
(22 lectures)

A) Extranuclear Structure of an atom (12 lectures)

Application of Bohr's Theory to H-atom and H-like ions, Sommerfeld's modification, H-atom spectra, Quantum Numbers.

Wave Mechanical Model: de broglie wave equation, Heisenberg's uncertainty principle and its significance, Schrodinger wave equation (qualitative approach), Radial and Radial probability functions; Angular and angular probability functions (qualitative idea only); s-, p- and d- type atomic orbital envelop diagrams; nomenclature of atomic orbitals.

Exchange Energy, Hund's rule, Limitations of Aufbau Principle, Ground State term Symbols of poly-electron species.

B) Periodic Table-atomic & Ionic Properties (10 lectures)

Modern form of Periodic Table (IUPAC version), Nomenclature of Super-heavy elements, Screening effect & Slater's rule.

Inert Pair Effect, Trends in atomic/ionic size, ionization energy, electronegativity & electron affinity of the s-, p-, d- and f- block elements; ionic potential and diagonal relationship in the periodic table.

Scales of Electronegativity- Mulliken Scale, Pauling Scale and Allred Rowchow Scale. Variation of Electronegativity with Bond Order & oxidation states.

UNIT II

(14-16 lectures)

A) Ionic Bonding (8-9 lectures)

Packing of Ions in Crystals, Radius Ratio Rules- applications & limitations; Lattice Energy- Born Lande Equation & its applications.

Born Haber Cycle and its applications; Solvation Energy, dissolution of ionic solutes in polar solvents, etc., Polarizability & Fajan's Rules; Stoichiometric & Non-stoichiometric defects in crystals (non-mathematical approach). van der Waals force, H-bonding and its applications.

B) Coordination Chemistry I (6-7 lectures)

Double Salts, Complex salts, Werner Coordination Theory, Mono, Poly and Ambidentate ligands, Chelate complexes, inner metallic complexes, IUPAC Nomenclature of complexes, applications of chelates in qualitative and quantitative chemical analysis.

Semester II

UNIT I

(24 lectures)

A) Radioactivity & Atomic Nucleus (12 lectures)

Radioactivity-Radioactive decay, half-life & average-life of radio-elements, Radioactive Equilibrium (transient and secular equilibria), isotopes, isotones, isobars and neuclear isomers.

Atomic Nucleus- Nuclear stability, n/p ratio & different modes of decay, Nuclear Binding Energy, nuclear forces, meson field theory, Nuclear Shell Model (elementary idea) & magic numbers.

Nuclear Reactions- Nuclear Fission, fusion, Spallation & transmutation of elements. Uses of Isotopes in Chemistry.

B) Covalent Bonding I (12 lectures)

Formal Charge, VSEPR Theory and Structure of Inorganic molecules, pseudorotation Hybridization, Bent's rule, dipole moment, Resonance.

UNIT II

(12-14 lectures)

A) Chemistry of the elements of Group 13 (6-7 lectures)

General trends in the oxidation states, hydrides, oxides/oxyacides and halides of B, Al, Ga, In, Tl. Special Feature in the Chemistry & Structure and Bonding of Boron Trihalides, diborane, Boron Nitride & Borazine.

B) Chemistry of the elements of Group 14 (6-7 lectures)

General trends in the oxidation states, catenation properties, Hydrides, Halides & Oxides of C, Si, Ge, Sn, Pb. Special Features in the Chemistry and Structure of graphite, fullerenes, silicates, silicones and chlorofluorocarbons, ultrapure silicon.

Semester III

Unit I

(24 lectures)

A) Covalent Bonding (II) (12 lectures)

I MOT : Qualitative approach to Molecular orbital theory, MO energy level diagrams of H_2, Li_2 to N_2, O_2 , F_2, CO, NO, CN^-, HF, HF_2^-, and BH_2.

II Metallic Bonding - Qualitative idea about Band Theory: Conductors, Semiconductors and insulators.

B) Redox Equilibrium (12 lectures)

Balancing Redox Reaction by ion electron method, standard Redox potential, Nernst equation, influence of pH and Pourbaix diagram, precipitation and complexation on redox potentials, formal potential, Feasibility of redox titrations, Redox potential at equivalence point, Redox Indicators, Redox Diagrams – Latimer and Frost diagrams of concerned elements and their application (typical examples)

Unit II

Group Chemistry II

(12 lectures)

Groups IA (1) & IIA (2)(6 lectures))

Solutions of alkali metals of liquid ammonia, Complexation with crown ethers and cryptands and related ligands. Basic beryllium acetate, Detection of the metal ions (Na^+, K^+, Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}) in qualitative analysis. Beryllium induced disease and its possible cure.

Group VB (15) (6 lectures)

Catenation, trends in the oxidation states, hydrides, halides and oxides and oxoacides. Special features in the chemistry of hydrazine, hydroxylamine and hydrazoic acid/azides, phosphonitrilic compounds.

Semester IV

Unit I

(18 lectures)

A) Acid- Base concepts, Solvents, Acid-Base Equilibria

Definitions of acids and bases (6 lectures)

Recapitulation of Arrhenius concepts, Solvent system Definition, Bronsted & Lowry's Definition. Relative strength of hydracids, strength of oxoacides and Pauling's rules, Lux Flood definition, Lewis definition, suparacids, HSAB principle, Solvent properties of water and liquid ammonia, Reactions in liquid ammonia.

Acid Base Equilibria (8 lectures)

pH (of strong acid / base solution and weak acid / base solution), Buffer solution, pH of a buffer solution, Henderson equation; buffer capacity; salt hydrolysis; pH of salt solutions (salt of strong acis / weak base; strong base / weak acid and weak acid / weak base); indicator, indicator constant and choice of indicator.

Solubility Equilibria (4 lectures)

Solubility product & common ion effect and their application in group analysis-precipitation of sulplides and hydroxides.

Unit II

(18-20 lectures)

Group Chemistry (III)

Group 16: General trends in chemistry of O, S, Se, Te- catenation, atomicity, halides and hydrides. Oxides and fluorides of S and Se. Special factures in the chemistry of the oxoacids of sulphur, Structure & bonding in O_2F_2, polythiazyl, tetrasulphur tetranitride.

Group 17: General trends in the chemistry of oxides, oxo acids and hydracids of F, Cl, Br, I. Special features in the chemistry of Interhologens, polyhalides, pseudohalogens, percholoric acid , periodic acid, potassium bromate, potassium hydrogen iodate.

Group 18: General trends in the Ionization energy and reactivites of He, Ne, Ar, Kr, Xe. Reactivity, Structure and bonding of the fluorides of xenon. Fluorination and fluoridation. Xe-N compounds.

Semester V

Unit I

(16 – 17 lectures)

Organomettalic Chemistry

18-e-rule and its application to: carbonyls (including carbonyl hydrides and carbonylates), nitrosyls, cyanides, metal-carbon sigma and π-bonded organometallics of transition metals; bonding and IR-spectra of carbonyls and nitrosyls; Zeise's salt-preparation, properties and structure; ferrocene-preparation, properties and structure. Elementary idea of fluxional molecules, oxidative additions, reductive elimination and insertion reactions. Homogeneous catalysis by organometallic compounds – hydrogenation, hydroformylation and polymerization of alkenes (Zieglar-Natta Catalyst).

Unit II

(20 – 21 lectures)

Coordination Chemistry (II)

***Isomerism, Reactivity and Stability*:** Constitutional, Geometrical and Optical isomerism in respect to coordination numbers 4 and 6. Mills Quibel Complex; examples of purely inorganic optical active complexes; labile and inert complexes; substitution in square planar complexes and trans-effect (examples and applications), choice of ligands and stability of various oxidation states of the 3d metal ions, idea of stability constant of complexes.

***Structure and Bonding*:** VBT, Crystal field theory, splitting of d^n configurations in octahedral and tetrahedral fields. Crystal field stabilization energy in weak and strong fields, pairing energy, Jahn-Teller distortion and its application in complexes; molecular orbital theory (elementary idea) – sigma and pi-bonding in octahedral complexes (pictorial approach).

Semester VI

Unit I

(16 lectures)

Magnetism and Spectra

Orbital and spin magnetic moment, spin only moments of $3d^n$ ions and their correlation with effective magnetic moments; Quenching of magnetic moments; Superexchange and anti-ferromagnetic interactions (elementary ideal with examples only)

d-d spectra, weak-field splitting schemes, qualitative Orgel diagrams for d^1, d^2, d^3, d^4, d^6, d^7, d^8 and d^9 systems and their spectroscopic ground states; selection rules for electronic spectral transitions, charge transfer spectra (elementary idea with examples only).

Unit II

(20-21 lectures)

Bioinorganic Chemistry (16 lectures)

Essential and trace elements of life; Role of metal ions in biology (Na^+, K^+, Ca^{2+}, Mg^{2+}, Fe^{3+}/Fe^{2+}, Cu^{2+}/Cu^+, Zn^{2+}).

(a) Active site structures and biofunctions of myoglobin, haemoglobin, cytochromes, ferredoxins, carboxypeptidase and carbonic anhydrase.

(b) Photosynthesis – PS-I and PS-II, sodium ion pump and ionophores, metal ion induced toxicity and chelation therapy; metal ions as drugs (cisplatin and a few gold drugs).

Chemistry of Lanthanides (4-5 lectures)

General characteristics with respect to electronic configuration, oxidation states and ionization enthalpies; lanthanide contraction and separation of lanthanides by ion exchange method.

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Semester I

Unit I

(8 - 10 lectures)

Extranuclear structure of atoms and chemical periodicit:

Application of Bohr's Theory, Hydrogen atoms spectra. Sommerfeld's model, quantum no. and their significance, Pauti's exclusion principle, Hunds rule, Wave nature of electrons, idea of atomic orbitals, s-, p- and d- type atomic orbital envelop diagrams. Aufbau principle and its limitations

Modern periodic Table, Trends in atomic and ionic radii, ionization energy, electronegativity and electron affinity.

Unit II

(4 -6 lectures)

Radioactivity and atomic nucleus

Group displacement law, law of radioactive decay, half-life & average life of radioelements, radioactive equilibrium.

Stability of nucleus, n/p ratio, nuclear bonding energy, fission, fusion, spallation, artificial radioactivity, use of radioisotopes.

Semester II

Unit I

(4-6 lectures)

Ionic Bonding: General characteristics of ionic compounds, radius ratio & its limitations, Lattice energy, Born Haber cycle, Fajan's rules of polarization.

Unit II

(4-6 lectures)

***Covalent Bonding (I)*:** VSEPR – theory, hybridization, Bond moment & dipole moment, hydrogen bonding and van der Waals forces.

Unit III

(4-6 lectures)

***Group Chemistry (I)*:** Trends in the chemistry of halides, hydrides and oxides

Group 13 & 14, Special features in the chemistry of chlorofluorocarbons, graphite, Boron trifluoride, boron nitride, borazine.

Semester III

Unit I

(4-6 lectures)

***Coordination Chemistry*:** Werner's Theory, Chelate complexes, IUPAC nomenclature of complexes.

Unit II

(8-10 lectures)

***Group Chemistry (II)* :** Trends in the hydrides, halides and oxides Group 15, 16, & 17; special features in the chemistry of hydrazine, hydroxylamine, sodium bismuthate, sodium thiosulphate, potassium bromate.

Semester IV

Unit I

(7-8 lectures)

***Covalent Bonding (II) and weak forces*.** MOT – simple MOs of Li_2 – N_2, O_2, F_2 and related species, Band Theory of metals (elementary idea only)

Unit II

(6-8 lectures)

Chemistry of d-block elements. Electronic configuration, oxidation states, trends in their atomic/ionic size and Ionization energy. VBT and magnetic properties of transition metal complexes.