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Post Code	007
Name of Post	Shift Chemist – Trainee
Minimum Educational Qualification	Regular M.Sc. (Chemistry) post graduate degree from AICTE/ UGC approved University/ Institute.

1. **Inorganic Chemistry:**

Stereochemistry and Bonding in Main Group Compounds: - VSEPR, Walsh diagram (triatomic and penta-atomic molecules), dπ-pπ bond, Bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules;

Metal-Ligand Equilibrium in Solution: - Stepwise and overall formation constants and their interaction, trends in stepwise constant, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand. Chelate effect and its thermodynamic origin, determination of binary formation constants by potentiometry and spectrophotometry;

Reaction Mechanism of Transition Metal Complexes: - Energy profile of a reaction, reactivity of metal complex, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anion reactions, reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the trans effect, mechanism of the substitution reaction. Redox reaction, electron transfer reactions, mechanism of one electron transfer reactions, outer sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions;

Metal-Ligand bonding: - Limitation of crystal field theory, molecular orbital theory for bonding in octahedral, tetrahedral and square planar complexes, π-bonding and molecular orbital theory;

HSAB Theory: - Classification of acids and bases as hard and soft; HSAB principle, theoretical basis of hardness and softness; Lewis-acid base reactivity approximation; donor and acceptor numbers, E and C equation; applications of HSAB concept. Solution - Determination of molecular weight of non-volatile and electrolyte/electrolyte by cryoscopic method and to determine the activity coefficient of an electrolyte. Determination of the degree of dissociation of weak electrolyte and to study the deviation from ideal behaviour that occurs with a strong electrolyte. Investigate the inversion of cane sugar in the presence of acid;

Electronic Spectral Studies of Transition Metal complexes: - spectroscopic ground states, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d1-d9 states), Selection rule for electronic spectroscopy. Intensity of various type electronic transitions. Calculations of 10Dq, B and β of and parameters, charge transfer spectra;

Magnetic Properties of Transition Metal Complexes: - Anomalous magnetic moments, Quenching of Orbital contribution. Orbital contribution to magnetic, magnetic exchange coupling and spin crossover;

Metal π–Complexes: - Metal carbonyl, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding structure and important reaction of transition metal, dinitrogen and dioxgen complexes; tertiary phosphine as ligand;

Metal Clusters: -Higher boranes, carboranes, metalloboranes and metallo-carboranes compounds with metal metal multiple bonds;

Optical Rotatory Dispersion and Circular Dichroism: - Linearly and circularly polarized lights; optical rotatory power and circular birefringence, elipticity and circular dichroism; ORD and Cotton effect, Faraday and Kerr effects; assignment of electronic transitions; applications of ORD and CD for the determination (i) absolute configuration of complexes and (ii) isomerism due to non – planarity of Chelate rings.

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2. Organic Chemistry:

Nature of Bonding in Organic Molecules: - Delocalized chemical bonding-conjugation, cross conjugation, resonance hyper conjugation, bonding in fullerenes, tautomerism. Aromaticity in benzenoid and non-benzoid compounds, alternate and non-alternate hydrocarbons. Huckel's rule, energy. Level of π-molecular orbitals, annulenes, anti-aromaticity, homo-aromaticity, PMO approach. Bonds weaker than covalent-addition compounds, crown ether complexes and cryptands, inclusion compounds, catenanes and rotaxanes;

Stereochemistry: -Strain due to unavoidable crowding Elements of symmetry, chirality, molecules with more than one chiral center, threo and ertythro isomers, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis, Asymmetric synthesis. Optical activity in the absence of chiral carbon (biphenyls, allenes and spirane chirallity due to helical shape. Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus;

Conformational analysis and linear free energy relationship: - Conformational analysis of cycloalkanes, decalines, effect of conformation on reactivity, conformation of sugars. Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. The Hammett equation and linear free energy relationship, substituents and reaction constants, Taft equation;

Reaction Mechanism: - Structure and Reactivity, Type of mechanisms, types of reaction, thermodynamic and kinetic requirements, kinetic and thermodynamic control. Hammond's postulate, Curtir-Hammett Principal, Potential energy diagrams, transition states and intermediates, methods of determining, mechanisms, isotopes effects;

Aliphatic Nucleophilic Substitution: - The SN2, SN1 mixed SNI and SN2 and SET mechanism. The neighboring group mechanism, neighboring group participation by p and s bonds, anchimeric assistance. Classical and nonclassical carbocations, phenonium ions, norbornyl systems, common carbocation rearrangements. Application of NMR. spectroscopy in the detection of carbocations. The SN1 mechanism. Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambient nucleophile, regioselectivity;

Aromatic Electrophilic Substitution: - The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeir reaction. Gatterman-Koch reaction;

Aromatic Nucleophilic Substitution: - The SNAr SN1, benzyne and SN1 mechanism, Reactivity effect of substrate structure, leaving group and attacking nucleophile. The Von Richter Sommelet-Hauser, and Smiles rearrangements;

Free Radical Reactions: - types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighboring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity. Allylic halogenation (NES); oxidation-of aldehydes to carboyxlic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts, Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction;

Addition Reactions: - Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio-and chemo-selectivity, orientation aid reactivity.

Addition to cyclopropane ring. Hydrogenation of double and triple bounds, hydrogenation of aromatic rings. Hydroboration, Michael reaction, sharpless asymmetric epoxidation;

Addition to Carbon-Hetero. Multiple bonds: - Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds acid esters and nitriles. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and usaturated carbonyl compounds. Wittig reaction. Mechanism of condensation reactions involving enolates-Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and. Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters;

Elimination Reactions: - The E2 E1 and E1CB mechanisms and their spectrum. Orientation of the double bond reactivity- effect of substrate structure, attacking base, the learning group and the medium mass, Mechanism and orientation in pyrolytic elimination;

Pericyclic Reactions: - Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and ally system. Classification of pericyclic reactions. Woodward-Hoffmann, correlation diagrams. FMO and PMO approach. Electro cyclic reactions-conrotatory and disrotatory motions, 4n 4n+2 and allyl systems. Cycloadditions-antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotrpic reactions. Sigmatropic rearrangements-suprafacial and antarafacial shifts of H, sigmatropic involving carbon moieties, 3,3 and 5,5 sigmatropic rearrangements. Claisen, Cope and aza-Cope rearrangements. Fluxional tautomerism. Ene reaction.

3. Physical Chemistry:

Introduction to Exact Quantum Mechanical Results: -Schrodinger equation and the postulates of quantum mechanics. Discussion of solution of the Schrodinger equation to some model systems viz, particle in a box, the harmonic. oscillator, the rigid rotor, the hydrogen atom and helium atom;

Approximate Methods: - The variation theorem, linear variation principle. Perturbation theory (First order and nondegenerate). Applications of variation method and perturbation theory to the Helium atom;

Molecular Orbital Theory: - Huckel theory of conjugated systems bond and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical cyclobutadiene etc. Introduction to extended Huckel theory;

Angular Momentum: - Ordinary angular momentum, generalized angular momentum, Eigen functions for angular Momentum, eigenvalues of angular momentum operator using ladder operators addition of angular momenta, spin, anti-symmetry and Pauli exclusion principle;

Classical Thermodynamics: - Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies. Partial molar free energy, partial molar volume and partial molar heat content and their significance. Determinations of these quantities. Concept of fugacity and determination of fugacity. Non-ideal systems: Excess functions for non-ideal solutions. Activity, activity coefficient, Debye Huckel theory for activity coefficient of electrolytic solution, determination of activity and activity coefficients; ionic strength. Appellation of phase rule to three component systems; second order phase transitions;

Statistical Thermodynamics: - Concept of distribution, thermodynamic, probability and most probable distribution. Ensemble averaging, postulates of averaging. Canonical, grand canonical and micro canonical ensembles. Corresponding distribution laws (Using Lagrange's method of undetermined multipliers). Partition functions-translation, rotational, vibrational and electronic

partition functions, Calculation of thermodynamic properties in terms of partition. Application of partition functions. Fermi-Dirac Statistics, distribution law and application to helium;

Chemical Dynamics: - Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and the activated complex theory; ionic reactions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions, treatment of unimolecular reactions. Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical-(hydrogen-bromine and hydrogen-chlorine reactions) and homogenous catalysis, kinetics of enzyme reactions, general features fo fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis ad the nuclear magnetic resonance method, dynamics of unimolecular reaction (Lindemann Hinshelwood and Rice-Ramsperger-Kassel-Marcus (RRKM) theories for unimolecular reactions);

Surface Chemistry: - Adsorption- Surface tension, capillary action, pressure difference across curved surface (Laplace. equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation), Surface films on liquids (Electro-kinetic phenomenon); **Micelles: -** Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization-phase separation anc: mass action models, solublization, micro emulsion, reverse micelles.;

Macromolecules: -Polymer-definition, types of polymers, electrically conducting, fire resistant, liquid crystal polymers, kinetics of polymerization, mechanism of polymerization. Molecular mass, number and mass average molecular mass, molecular mass determination Osmometry, viscometry, diffusion and 1ight scattering methods), sedimentation, chain configuration of macromolecules, of average dimension of average dimension of various chain structures;

Non-Equilibrium Thermodynamics: - Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equations for different irreversible processes (e.g., heat flow, chemical reaction etc.) transformations of the generalized fluxes and forces, non-equilibrium stationary states, phenomenological equations, microscopic reversibility and Onsager's reciprocity relations, electro kinetic phenomena, diffusion, electric conduction;

Electrochemistry: - Electrochemistry of solutions. Debye-Huckel-Onsager treatment and its extension, ion solvent interactions. Debye-Huckel-Jerum mode. Thermodynamics of electrified interface equations. Derivation of electro capillarity, Lippmann equations (surface excess), methods of determination. Structure of electrified interfaces. Over potentials, exchange current density, derivation of Butler Volmer equation, Tafel plot. Quantum aspects of charge transfer at electrodes-solution interfaces, quantization of charge transfer, tunneling. Semiconductor interfaces-theory of double layer at semiconductor, electrolyte solution interfaces, structure of double layer interfaces. Effect of light at semiconductor solution interface. Polarography theory, Ilkovic equation; half wave potential and its significance.

4. Group Theory, Spectroscopy and its Applications

Symmetry and Group theory in Chemistry: - Symmetry elements and symmetry operation, definition of group, subgroup. Conjugacy relation and classes. Point symmetry group. Schonfilies symbols, representations of groups by matrices (representation for the Cn, Cnv, Cnh, Dnh, group to be worked out explicitly). Character of a representation. The great orthogonality theorem (without proof), and its importance. Character tables and their use; spectroscopy. Derivation of

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character table for C2vand C3v point group Symmetry aspects of molecular vibrations of H2O molecule;

Microwave Spectroscopy: - Classification of molecules, rigid rotor model, effect of isotopic substitution on the transition frequencies, intensities, non-rigid rotor. Stark effect, nuclear and electron spin interaction and effect of external field. Applications;

Infrared-Spectroscopy: - Review of linear harmonic oscillator, vibrational energies of diatomic molecules, zero-point energy, force constant and bond strengths; anharmonicity, Morse potential energy, diagram, vibration-rotation spectroscopy. P.Q.R. branches, Breakdown of Oppenheimer approximation; vibrations of polyatomic molecules, Selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factors affecting the band positions and intensities, far IR region, metal ligand vibrations, normal co-ordinate analysis, Applications;

Raman Spectroscopy: - Classical and quantum theories of Raman effect. Pure rotational, vibrational and vibrational-rotational Raman spectra, selection rules, mutual exclusion principle, Resonance Raman spectroscopy, coherent and stokes Raman spectroscopy (CARS), Applications;

Electronic Spectroscopy- Molecular Spectroscopy: - Energy levels, molecular orbitals. vibronic transitions, vibrational progressions and geometry of the excited states Franck-Condon principle, electronic spectra of polyatomic molecules. Emission ideas of last -active and non-radioactive decay, conversions. Spectra of transition metal complexes, charge-transfer spectra; **Photoelectron Spectroscopy: -** Basic principles; Photo – electric effect, ionization process, Koopman's theorem. Photoelectron spectra of simple molecules, ESCA, chemical information for ESCA. Auger electron spectroscopy-basic idea, Applications;

Nuclear Magnetic Resonance Spectroscopy: -Nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift and its measurements, factors, influencing chemical shift, de-shielding, spin-spin interactions, factors influencing coupling constant "j" Classification (AXB, AMX. ABC, A2B2 etc.), spin decoupling; basic ideas about instrument, NMR studies of nuclei other than protin-13C, 19F and 31P. FT NMR, advantages of FT NMR; Applications.

Nuclear Quadrupole Resonance Spectroscopy: - Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant, splitting. Applications;

Electron Spin Resonance Spectroscopy: - Basic principles, zero field splitting and Kramer's degeneracy, factors affecting the 'g' value. Isotropic and anisotropic hyperfine coupling constants spin Hamiltonian. Spin densities and Mc Connell relationship, measurement techniques, applications, Applications;

X-ray Diffraction: - Brag condition, Miller indices, Laue Method, Bragg method, Debye Scherrer method of X-ray structural analysis of crystals, index reflections, identification of unit cells from systematic absences in diffraction pattern, Structure of simple lattices and X-ray intensities, structure factor and its relation to intensity and electron density, phase problem. Description of the procedure for an X-ray structure analysis, absolute configuration of molecules;

Electron Diffraction: - Scattering intensity vs. scattering angle, Wierl equation, measurement technique, elucidation of structure of simple gas phase molecules. Low energy electron diffraction. and structure of surfaces;

Neutron Diffraction: - Scattering of neutrons by solids measurement techniques Elucidation of structure ordered unit cells.

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5. Photochemistry:

Photochemical Reaction: -Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry;

Determination of Reaction Mechanism: - Classification, rate constants and life times of reactive energy state, determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions-photo dissociations, gas-phase photolysis;

Photochemistry of Alkenes: - Intramolecular reactions of the olefinic bond-geometrical isomerism, cyclisation reactions, rearrangement of 1,4-and 1,5-dienes;

Photochemistry of Aromatic Compounds: - Isomerisations, additions and substitutions;

Photochemistry of Carbonyl Compounds: - Intramolecular reactions of carbonyl compounds-saturated, cyclic and acyclic, β, γ unsaturated and α , β unsaturated compounds, cyclohexadienones. Intermolecular cyloaddition reactions-dimerisations and oxetane formation;

Miscellaneous Photochemical Reactions: - Photo-Fries reactions of annilides, Photo-Fries rearrangement. Barton reaction. Singlet molecular oxygen and its reactions. Photochemical formation of smog. Photodegradation of polymers. Photochemistry of vision.

6. Solid State Chemistry:

Solid State Reactions: - General principles, experimental procedure, co-precipitation as a precursor to solid state reactions, kinetics of solid state reactions;

Crystal Defects and Non-Stoichiometry: - Perfect and imperfect crystals, intrinsic and extrinsic defects-point defects, line and plane defects, vacancies-Schottky detects and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formation, colour centres, non-stoichiometry and defects;

Electronic Properties and Band Theory: - Metals insulators and semiconductors, electronic structure of solids band theory band structure of metals, insulators and semiconductors, Intrinsic and extrinsic., semiconductors, doping semiconductors, p-n junctions, super conductors. Optical Properties-Application of optical and electron microscopy. Magnetic Properties- . Classification of materials: Effect of temperature calculation of magnetic moment, mechanism of ferro and anti-ferromagnetic ordering super exchange;

Organic Solids: - Electrically conducting solids. organic charge transfer complex, organic metals, new superconductors;

Liquid Crystals: - Types of liquid crystals: Nematic, Smectic, Ferroelectric, Antiferroelectric, Various theories of LC, Liquid crystal display, New materials.

7. Biological Chemistry:

Cell Structure and Functions: - Structure prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparison of plant and animal cells, Overview and their functions, comparison of plant and animal cells. Overview of metabolic processes-catabolism and anabolism. ATP - the biolegreal energy currency. Origin of life-unique properties of carbon chemical evolution and rise of living systems. Introduction to bio-molecules, building blocks of bio-Macromolecules;

Carbohydrates: - Conformation of monosaccharides, structure and functions of important derivatives of mono-saccharides like glycosides, deoxy sugars, myoinositol, amino sugars. N-acetylmuramic acid, sialic acid disaccharides and polysaccharides. Structural polysaccharides

cellulose and chitin. Storage polysaccharides-starch and glycogen. Structure and biological function of glucosaminoglycans of mucopolysaccharides. Carbohydrates of glycoproteins and glycolipids. Role of sugars in biological recognition. Blood group substances. Ascorbic acid;

Lipid: - Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Liproproteins-compositiion and function, role in atherosclerosis. Properties of lipid aggregates-micelles, bilayers, liposomes and their possible biological functions. Biological membranes. Fluid mosaic model of membrane structure. Lipid metabolism-b-oxidation of fatty acids;

Amino-acids, Peptides and Proteins: - Chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of proteins. force responsible for holding of secondary structures. a-helix, -b-sheets, super secondary structure, triple helix structure of collagen. Tertiary structure of protein-folding and domina structure. Quaternary structure. Amino acid metabolism-degradation and biosynthesis of amino acids, sequence determination : chemical/enzymatic/mass spectral, racemization/detection. Chemistry of oxytocin and tryptophan releasing hormone (TRH);

Nucleic Acids: - Purine and pyrimidine bases of nucleic acid base pairing via H-bonding. Structure of ribonucleic acids (RNA) and deoxyribonucleic acid (DNA), double helix model of DNA and forces responsible for holding it. Chemical and enzymatic hydrolysis of nucleic acids.The chemical basis for heredity, an overview of replication of DNA, transcription, translation and genetic code. Chemical synthesis of mono and trinucleoside.

8. Analytical Chemistry:

Introduction: - Role of analytical chemistry Classification of analytical methods classical and instrumental. Types of instrumental analysis. Selecting an analytical method. Neatness and cleanliness. laboratory operations and practices. Analytical balance. Techniques of weighing, errors. Volumetric glassware cleaning and calibration of glassware. Sample Volumetric glassware cleaning and Calibration of glassware. Sample preparation-dissolution and decompositions. Gravimetric techniques. Selecting and handling or reagents. Laboratory notebooks. Safety in the analytical laboratory;

Errors and Evaluation: - Definition of terms in mean and median. Precision-standard deviation, relative standard deviation. Accuracy-absolute error, relative error. Types of error in experimental data determinate (systematic), indeterminate (or random) and gross. Sources of error and the effects upon the analytical results. Methods for reporting analytical data. Statistical evaluation of data-indeterminate errors. The uses of statistics;

Concept of Equilibrium: - Solvents and solutions, general treatment of equilibria in aqueous medium involving monoprotic weak acid and weak base, and salts of weak acids and weak bases. Activity and concentration, Effect of electrolytes on chemical equilibria, Calculation of pH, Constructing titration curves from charge balance and mass balance equations, Acid-base titrations and theory of pH indicators, Complications equilibria and complex metric titrations, Redox equilibria and redox titration, Theory of redox indicators, Precipitation reaction and precipitation titrations and theory of adsorption indicators;

Spectrophotometric Determination of Stoichiometry of Complexes: -Job's method of continuous variation, mole ratio and slope ratio analysis, Advantages and limitations, Typical examples;

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Automation in the Laboratory: - Principles of automation, Process control through automated instruments, Auto analyzers (single channel and multi-channel), Basic sequences of multi-fold operational analyzers in segmented and non-segmented flows; Polarography, Atomic Spectroscopy, Molecular Spectroscopy;

Separation Methods: - Principle of chromatography, Classifications of chromatography, Techniques of planar and column chromatography, Gas chromatography, High performance liquid chromatography;

Thermal Analysis: - Theory, methodology and applications of thermo gravimetric analysis (TGA), Differential Thermal Analysis (DTA), and Differential scanning calorimetry (DSC). Principles, techniques and applications of thermometric titration methods;

Food analysis: - Moisture, ash, crude protein, fat crude fiber, carbohydrates, calcium, potassium, sodium and phosphate. Food adulteration-common adulterants in food, contamination of foods stuffs. Microscopic, examination of foods for adulterants. Pesticide analysis in food products. Extraction and purification of sample. HPLC. Gas chromatography for organophosphates. Thin-layer chromatography for identification of chlorinates pesticides in food products;

Analysis of Water Pollution: - Origin of Waste water, types, water pollutants and their effects. Sources of water pollution-domestic, industrial agricultural soil and radioactive wastes as sources of pollution. Objectives of analysis-parameter for analysis-color, turbidity, total solids, conductivity, acidity, alkalinity, hardness- temporary and permanent, chloride, sulphate, fluoride, silica, phosphates and different forms of nitrogen, Heavy metal pollution-public health significance of cadmium, chromium, copper, lead, zinc, manganese, mercury and arsenic. General survey of instrumental technique for the analysis of heavy metals in aqueous systems. Measurements of DO, BOD, and COD. Pesticides as water pollutants and analysis. Water pollution law; and standards.

Analysis of soil, Fuel, Body Fluids and Drugs: - (a) **Analysis of Soil** - moisture pH total nitrogen, phosphorus, silica, lime, magnesia, manganese, Sulphur and alkali salts, (b) **Fuel analysis** – classification of fuel- solid, liquid, gas, characteristics of fuel- calorific value units (lower, higher) and its determination- Bomb Calorimeter method, Solid Fuels- Ultimate and proximate analysis-heating values-Rank Analysis/ grading of coal, Liquid fuels-flash point, aniline point, octane number and carbon residue. Gaseous fuels-produced gas and water gas-calorific value, (c) **Clinical Chemistry** - Composition of blood-collection and preservation of samples. Clinical analysis. Serum electrolytes, blood glucose, blood urea nitrogen, uric acid, albumin, globulins, barbiturates, acid and alkaline phosphates. Immunoassay: principles of radio immunoassay (RIA) and applications. The blood gas analysis trace elements in the body, (d) **Drug analysis -** Narcotics and dangerous drug. Classification of drugs. Screening by gas and thin-layer chromatography and spectrophotometric measurements.

9. Environmental Chemistry:

Atmosphere: - Atmospheric layers, Vertical temperature profile, heat/radiation budget of the earth atmosphere systems. Properties of troposphere, thermodynamic derivation of lapse fate. Temperature Inversion. Calculation of Global means temperature of the atmosphere. Pressure vantlon in atmosphere and scale height. Biogeochemical cycles of carbon, nitrogen, sulphur, phosphorus, oxygen. Residence times;

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Atmospheric Chemistry: - Sources of trace atmospheric constituents- nitrogen oxides, Sulphur dioxide and other sulphur compounds, carbon oxides, chlorofluorocarbons and other halogen compounds, methane and other hydrocarbons;

Tropospheric Photochemistry: - Mechanism Photochemical decomposition of NO2 and formation of ozone. Formation of oxygen. atoms, hydroxyl, hydroperoxy and organic radicals and hydrogen peroxide. Reactions of hydroxyl radicals with methane and other organic compounds. Reaction of OH radicals with SO2 and NO2. Formation of Nitrate radical and its reactions. Photochemical smog meteorological conditions and chemistry of its formation;

Air Pollution: - Air pollutants and their classifications. Aerosols-sources, size distribution and effect on visibility, climate and health, **Acid Rain -** Definition, Acid rain precursors and their aqueous and gas phase atmospheric oxidation reactions. Damaging effects on aquatic life, plants, buildings-and health. Monitoring of SO2 and NO2. Acid rain control strategies Mechanism of Ozone formation, Mechanism of catalytic ozone depletion, Discovery of Antarctic Ozone hole and Role of chemistry and meteorology. Control Strategies. **Green House Effect -** Terrestrial and solar radiation Spectra, Major green house gases and their sources and Global warming potentials. Climate change and consequences. **Urban Air Pollution -** Exhaust emissions, damaging effects of carbon monoxide. Monitoring of CO. Control strategies;

Aquatic Chemistry and Water Pollution: - Redox chemistry in natural waters. Dissolved oxygen, biological, oxygen demand, chemical oxygen demand, determination of DO, BOD and COD. Aerobic and anaerobic reactions of organic sulphur and nitrogen compounds in water acid-base chemistry of fresh water and sea water. Aluminum, nitrate and fluoride in water. Petrification. Sources of water pollution. Treatment of waste and sewage. Purification of drinking water, techniques of purification and disinfection;

Environmental Toxicology: - Toxic heavy metals: Mercury, lead, arsenic and cadmium. Causes of toxicity. Bioaccumulation, sources of heavy metals. Chemical speciation of Hg, Pb, As, and Cd. Biochemical and damaging effects, Toxic Organic Compound - Pesticides, classification, properties and uses of organochlorine and ionospheres pesticides detection and damaging effects, Polychlorinated biphenyls - Properties, use and environmental continuation and effects. Polynuclear Aromatic Hydrocarbons - Source, structures and as pollutants;

Soil and Environmental Disasters: - Soil composition, micro and macronutrients, soil pollution by fertilizers, plastic and metals. Methods of re-mediation of soil. Bhopal gas tragedy, Chernobyl, Three mile island, Minamata Disease, Sevoso (Italy), London smog.