ANNEXURE-II

SCHEME AND SYLLABUS FOR RECRUITMENT TO THE POST OF ASSISTANT SCIENTIST (ANALYST GRADE -II) IN TELANGANA POLLUTION CONTROL BOARD

SCHEME OF EXAMINATION

WRITTEN EXAMINATION (OBJECTIVE TYPE)	No.of Questions	Duration (Minutes)	Maximum Marks
PAPER-I: General Studies And General Abilities	150	150	150
PAPER-II: Chemistry	150	150	150
		Total Marks	**300**

Syllabus
PAPER-I: GENERAL STUDIES AND GENERAL ABILITIES

1. Current Affairs – Regional, National and International
2. International Relations and Events.
3. General Science; India's achievements in Science and Technology
4. Environmental issues and Disaster Management
5. Economy of India and Telangana
6. Geography of India with a focus on Telangana
7. Indian Constitution and Polity with a focus on local self Government
8. Society, Culture, Heritage, Arts and Literature of Telangana
9. Policies of Telangana State
10. History of Modern India with a focus on Indian National Movement
11. History of Telangana with special emphasis on Movement for Telangana Statehood
12. Logical Reasoning, Analytical Ability and Data Interpretation
13. Basic English

PAPER-II: CHEMISTRY

1.1 **Atomic structure:** Schrodinger wave equation, significance of ψ and ψ^2 quantum numbers and their significance, radial and angular probability, shapes of orbitals, relative energies of atomic orbitals as a function of atomic number. Electronic configurations of elements; Aufbau principle, Hund's multiplicity rule, Pauli exclusion principle.

1.2 **Chemical periodicity**: Periodic classification of elements, salient characteristics of s,p,d and f block elements. Periodic trends of atomic radii, ionic radii, ionization potential, electron affinity and electro-negativity in the periodic table.

1.3 **Chemical bonding**: Types of bonding, overlap of atomic orbitals, sigma and pi-bonds, hydrogen and metallic bonds. Shapes of molecules bond order, bond length, V.S.E.P.R. theory and bond angles. The concept of hybridization and shapes of molecules and ions. Molecular orbital theory, Molecular orbital energy diagrams of homo diatomic molecules

1.4 **Oxidation states and oxidation number**: Oxidation and reduction, oxidation numbers, common redox reactions, ionic equations. Balancing of equations for oxidation and reduction reactions.

1.5 **Acids and bases**: Bronsted and Lewis theories of acids and bases. Hard and soft acids and bases. HSAB theory.

1.6 **Chemistry of elements:**

i) **Hydrogen**: Its unique position in the periodic table, isotopes, ortho and para hydrogen, industrial production, heavy water.

ii) **Chemistry of 's' and 'p' block elements**: Electronic configuration, general characteristics properties, inert pair effect, allotrophy and catenation. Special emphasis on solutions of alkali and alkaline earth metals in liquid ammonia. Preparation, properties and structures of boric acid, borates, boron nitrides, borohydride (diborane), carboranes, oxides and oxyacids of nitrogen, phosphorous, sulphur and chlorine; interhalogen compounds, polyhalide ions, pseudohalogens, fluorocarbons and basic properties of halogens. Chemical reactivity of noble gases, preparation, structure and bonding of noble gas compounds.

iii) **Chemistry of 'd' block elements**: Transition metals including lanthanides, general characteristic properties, oxidation states, magnetic behaviour, colour. First row transition metals and general properties of their compounds (oxides, halides and sulphides); lanthanide contraction.

1.7 **Extraction of metals**: Principles of extraction of metals iron, nickel, copper, silver and gold.

1.8 **Nuclear Chemistry**: Nuclear reactions; mass defect and binding energy, nuclear fission and fusion. Nuclear reactors; radioisotopes and their applications.

1.9 **Coordination compounds**: Nomenclature, isomerism and theories of coordination compounds and their role in nature and medicine.

1.10 **ENVIRONMENTAL POLLUTION and CONTROL TECHNOLOGIES: Environmental Pollution & control:** Classification of pollution, causes, effects. **Air Pollution:** Primary and secondary pollutants, Ambient air quality standards. **Water pollution:** Sources and types of pollution, drinking water quality standards. **Soil Pollution:** Sources and types, Impacts of modern agriculture, degradation of soil. **Noise Pollution:** Sources and Health hazards, standards, **Pollution from Power projects:** Thermal and Nuclear,**Solid waste:** Municipal Solid Waste management. **Pollution control technologies:** Wastewater Treatment methods: Primary, secondary and Tertiary, Air: Overview of air pollution control technologies, Concepts of bioremediation. Field visit. **Global Environmental Problems And Global Efforts: C**limate change and impacts on human environment. Ozone depletion and Ozone depleting substances (ODS). Deforestation and desertification.

1.11 Chemistry of Water

a) **Sources of water & Quality:** Sources of contamination of water,Chemical, Physical and Biological characteristics of water, Drinking waterstandards, standards and effects of contaminated water , water born diseases & problems.

b) **General purification Methods of water:** Sedimentation, Filtration, Coagulation, Distillation &reverse osmosis and **Disinfection**, Types of Disinfection, ideal Disinfectant, Mechanism of Disinfection, Efficiency of Disinfection, **Chlorination**, Types of Chlorination. **Coagulation**:Types of Coagulation, Mechanism, Efficiency of Coagulation.

c) **Water Softening Method:** Heating, Lime-Soda Process, Caustic- Soda Process, Softening with Calgon, Zeolite process, Ion-Exchange process.Municipal Water Conditioning and Industrial effluent Treatment.

d) **Qualitative & Quantitative analysis:**
Qualitative analysis: Classification of anions and cations. Reactions involvedin the Separation and identification of anions and cations. Qualitative analysis of Organic compounds.
Quantitative analysis: Volumetric analysis and Gravimetric Analysis

I. **Volumetric analysis:** Theory of Volumetric analysis Types of reactions, Titration curves w.r.t neutralization, redox, precipitation &Complexometric titrations. Theory of Indicators.

II. **Gravimetric Analysis:** Theory of gravimetric analysis, Formation of precipitate, conditions or precipitation, Impurities in precipitate. Washing, drying & ignition of precipitates. Principles and applications of Chromatographic techniques, UV,IR and NMR.

2.1 **Bonding and shapes of organic molecules**: Electronegativity, electron displacements-inductive, mesomeric and hyperconjugative effects; bond polarity and bond polarizability, dipole moments of organic molecules; hydrogen bond; effects of solvent and structure on dissociation constants of acids and bases; bond formation, fission of covalent bonds; homolysis and heterolysis; reaction intermediates-carbocations, carbanions, free radicals and carbenes; generation geometry and stability; nucleophiles and electrophiles.

2.2 **Chemistry of aliphatic compounds**: Nomenclature; alkanes-synthesis, reactions (free radical halogenation) – reactivity and selectivity, sulphonation-detergents; cycloalkanes-Baeyers' strain theory; alkanes and alkynes-synthesis, electrohilic addition; reactions, Markownikov's rule, peroxide effects, 1-3-dipolar addition; nucleophilic addition to electron-deficient alkenes; polymerization; relative acidity; synthesis and reactions of alkyl halides, alkanols, alkanals, alkanones, alkanoic acids, esters, amides, nitriles, amines, acid anhydrides, α,β - unsatuarated ketones, ethers and nitro compounds.

2.3 **Stereochemistry of carbon compounds**: Elements of symmetry, chiral and achiral compounds. Fischer projection formulae; optical isomerism of lactic and tartaric acids, enantiomerism and diastereo-isomerism; configuration (relative and absolute); conformations of alkanes upto four carbons, cyclohexane and dimethylcyclo-hexanes their potential energy **D,L** and **R,S** notations of compounds containing chiral centers; projection formulae-Fischer, Newman and sawhorse of compounds containing two adjacent chiral centers; meso and dl-isomers, erythro and threo isomers; racemization and resolution; examples of homotopic, enantiotopic and diasteretopic atoms and groups in organic compounds, geometrical isomers; **E** and **Z** notations. Stero-chemistry of SN1, SN2,E1 and E2 reactions.

2.4 **Organometallic compounds**: Preparation and synthetic uses of Grignard reagents, alkyl lithium compounds.

2.5 **Chemistry of aromatic compounds**: Aromaticity; Huckel's rule; electrophilic aromatic substitution-nitration, sulphonation, halogenation (nuclear and side chain), Friedel-Crafts alkylation and acylation, substituents effect; chemistry and reactivity of aromatic halides, phenols, nitro, diazo, dia-zonium and sulphonic acid derivatives, benzyne reactions.

2.6 **Chemistry of biomolecules**: (i) **Carbohydrates**: Classification, reactions, structure of glucose, D,L-configuration, osazone formation; fructose and sucrose; step-up step-down of aldoses and ketoses; and their interconversion, (ii) **Amino acids:** Essential amino acids; zwitterions, isoelectric point, polypeptides; proteins; methods of synthesis of -amino acids. (iii) Elementary idea of oils, fats, soaps and detergents.

2.7 Beer's Lambert Law and its applications in quantitative annalists Basic principles and applications of UV, visible, IR and NMR spectroscopy of simple organic molecules.

3.1 **Gaseous state**: Deviation of real gases from the equation of state for an ideal gas, Vander Waals and Viril equation of state, critical phenomena, principle of corresponding states, equation for reduced state. Liquification of gases, distribution of molecular speed, collisions between molecules in a gas; mean free path, specific heat of gases.

3.2 **Thermodynamics**:

(i) **First Law and its applications:** Thermodynamic systems, states and processes work, heat and internal energy, zeroth law of thermodynamics, various types of work done on a system in reversible and irreversible processes. Calorimetry and thermo-chemistry, enthalpy and enthalpy changes in various physical and chemical processes, Joule-Thomson effect, inversion temperature. Heat capacities and temperature dependence of enthalpy and energy changes.

(ii) **Second Law and its applications:** Spontaneity of a process, entropy and entropy changes in various processes, free energy functions, criteria for equilibrium, relation between equilibrium constant and thermodynamic quantities.

3.3 **Phase rule and its applications**: Equilibrium between liquid, solid and vapours of a pure substance. Number of components, phases and degrees of freedom; phase rule and its applications; simple systems with one (water) and two components (lead-silver). Distribution law, its modifications, limitations and applications.

3.4 **Solutions**: Solubility and its temperature dependence, partially miscible liquids, upper and lower critical solution temperatures, vapour pressures of liquids over their mixtures, Raoult's and Henry's law, fractional and steam distillations.

3.5 **Colligative Properties**: Dilute solutions and colligative properties, determination of molecular weights, using colligative properties.
3.6 **Electro-chemistry**: Ions in solutions, ionic equilibria, dissociation constants of acids and bases, hydrolysis, pH and buffers, theory of indicators and acid-base titrations. Conductivity of ionic solutions, its variation with concentration, Ostwald's dilution law, Kohrausch law and its application. Transport number and its determination. Faraday's laws of electrolysis, galvanic cells and measurements of their e.m.f., cell reactions, standard cell, standard reduction potential Nernst equation, relation between thermodynamic quantities and cell e.m.f., fuel cells, potentiometric titrations.
3.7 **Chemical kinetics**: Rate of chemical reaction and its dependence on concentrations of the reactants, rate constant and order of reaction and their experimental determination; differential and integral rate equations for first and second order reaction, half-life periods; temperature dependence of rate constant and Arrhenius parameters; elementary ideas regarding collision and transition state theory.
3.8 **Photochemistry**: Absorption of light, laws of photochemistry, quantum yield, the excited state and its decay by radiative, non-radiative and chemical pathways; simple photochemical reactions.
3.9 **Catalysis**: Homogeneous and heterogeneous catalysis and their characteristics, mechanism of heterogeneous catalysis; enzyme catalysed reactions (Michaelis-Menten mechanism)
3.10 **Colloids**: The colloidal state, preparation and purification of colloids and their characteristics properties; lyophilic and lyophobic colloids and coagulation; protection of colloids; gels, emulsions, surfactants and micelles.