

**STATE FORENSIC SCIENCE LABORATORY
GOVT OF WEST BENGAL
37/1/2 BELGACHIA ROAD
KOLKATA 700037**

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A Draft Syllabus of Preliminary Examination for Recruiting Scientific Officer under Chemistry Division in State Forensic Science Laboratory, Govt. of West Bengal, Kolkata through Public Service Commission, Govt of West Bengal

Scheme

Full Marks	: 100
No of Question	: 100 (1 mark for each correct answer, deduction of 1/3 mark for each wrong attempt)
Question Type	: MCQ
Distribution of Marks	: 20 questions on English 10 questions on Current Affairs 70 questions on Chemistry

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Syllabus

- English** : Correct use of words, correction of sentences, use of common phrases, synonyms, antonyms, narration, voice change, article, preposition etc.
- Current Affairs** : Events of political or social significance that happens at the current time.
- Chemistry** : Questions will be of graduation standard (Syllabus given below)

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I. Organic Chemistry:

Fundamental organic chemistry: Inductive effect, hyper conjugation, resonance, electrophiles and nucleophiles, reactive intermediates: carbocations, carbanions and radicals (stability and reactivity).

Stereochemistry of carbon compounds: Different types of isomerism, geometrical and optical isomerism, optical activity, asymmetric carbon atom, elements of symmetry (plane and centre), chirality, enantiomers and diastereomers, R and S nomenclature, E and Z nomenclature, D and L nomenclature.

Alkanes, alkenes and alkynes: Alkanes: Preparation-catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent, free-radical halogenation of alkanes; Alkenes: General methods of synthesis of alkenes, electrophilic addition reaction, bromination and hydrohalogenation, Markownikoff's addition, peroxide effect, hydroboration, ozonide formation, polymerization reaction of alkenes; Alkynes: General methods of synthesis of alkynes, acidity, hydration and substitution reactions of alkynes.

Aromatic Hydrocarbons: Preparation & structure of benzene; general mechanism of electrophilic substitution reactions of benzene; synthesis of aromatic compounds using nitration, halogenation, Friedel-Craft's reactions; side chain oxidation of alkyl benzenes.

Aldehydes and ketones: Methods of synthesis, physical properties, Cannizzaro reaction, distinction of aldehydes and ketones, Aldol condensation, Perkin reaction, Benzoin condensation, Claisen condensation, Oxidation and reduction reactions.

Alkyl and Aryl halides: S_N1 , S_N2 , E1 and E2 reactions, Saytzeff and Hoffmann elimination reactions, Nucleophilic aromatic substitution.

Carboxylic acids and their derivatives: Acidity of carboxylic acids and effects of substituents on acidity, chemical reactivity, esterification of carboxylic acids and hydrolysis of esters ($B_{AC}2$ and $A_{AC}2$ only).

Phenols and their derivatives: Synthesis, acidic character and chemical reactions of phenols, Kolbe reactions, Reimer-Tiemann reaction, Fries rearrangement, Claisen rearrangement.

Organometallic compounds: Preparations and reactions of Grignard Reagents, application of Grignard reagents in organic synthesis [1^0 , 2^0 , and 3^0 -alcohols, aldehydes, ketones and carboxylic acids].

Organic compounds containing nitrogen: Aromatic nitro compounds – reduction under different conditions, Methods of synthesis of aliphatic amines, Heinsberg's method of amine separation, Hofmann degradation, Gabriel's phthalimide synthesis, distinction of primary, secondary and tertiary amines; Methods of synthesis of aromatic amines, basicity of aliphatic and aromatic amines, Diazotization and coupling reactions; Synthetic applications of benzene diazonium salts.

Amino acids, Proteins: Methods of synthesis of α -amino acids (glycine and alanine using Gabriel's phthalimide synthesis and Strecker synthesis), Physical properties, Zwitterion structures, isoelectric point.

Principles of organic qualitative analysis: Reactions involving the detection of special elements N, S and Cl in an organic compound (only Lassaigne's test). Reactions involving the detection of the following

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functional groups: Aromatic primary amino group (Diazo-coupling reaction); Nitro group (Mulliken Barker's test); Carboxylic acid group (reaction with NaHCO_3); Phenolic OH (FeCl_3 test); Carbonyl (aldehyde and ketone) group (DNP Test).

Fuels: Classification of fuel, heating values, Origin of coal, carbonization of coal, coal gas, producer gas, water gas, coal based chemicals. Origin and composition of petroleum, petroleum refining, cracking, knocking, octane number, anti-knock compounds, Kerosene, liquefied petroleum gas (LPG), liquefied natural gas (LNG).

Fertilizers: Manufacture of ammonia and ammonium salts, urea, superphosphate, biofertilizers.

Polymers: Basic concept, structure and types of plastics, polythene, polystyrene, phenol-formaldehydes, PVC; manufacture, physical properties and uses of natural rubber, synthetic rubber, silicone rubber; synthetic fibres: Nylon-66, polyester, terylene, rayon; foaming agents, plasticizers and stabilizers.

Paints, Varnishes and Synthetic Dyes: Primary constituents of a paint, binders and solvents for paints, oil based paints, latex paints, baked-on paints (alkyd resins), constituents of varnishes, formulation of paints and varnishes, synthesis of Methyl orange, Congo red, Malachite green, Crystal violet.

Drugs and pharmaceuticals: Concept and necessity of drugs and pharmaceuticals; preparation and uses of Aspirin, Paracetamol, Sulphadiazine, Quinine, Chloroquine, Phenobarbital, Metronidazole; Fermentation Chemicals : Production and purification of ethyl alcohol, citric acid, lactic acid, Vitamin B12, Penicillin.

Fats-Oils-Detergents : Fats and oils, natural fat, edible and inedible oil of vegetable origin; Common fatty acids, glycerides; Hydrogenation of unsaturated oil, production of vanaspati and margarine; Production of toilet and washing soaps, Enzymebased detergents, detergent powder, liquid soaps.

Pesticides: Common pesticides, Production, applications and residual toxicity of gammaxane, aldrin, parathion, malathion, DDT, paraquat, decamethrin.

Food Additives: Food flavour, food colour, food preservatives, artificial sweeteners, acidulants, alkalies, edible emulsifiers and edible foaming agents, sequesterants – uses and abuses of these substances in food beverages.

Chemical Explosives: Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX); Introduction to rocket propellants.

II. Inorganic Chemistry:

Chemical Bonding: Ionic bonding: General characteristics of ionic compounds, sizes of ions, radius ratio rule and its limitation, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds, Born Haber cycle; Covalent bonding: General characteristics of covalent compounds, valence-bond approach, directional character of covalent bond, hybridization involving s-, p-, d orbitals, multiple bonding, Valence Shell Electron Pair Repulsion (VSEPR) concept, shapes of simple molecules and ions, bond moment and dipole moment, partial ionic character of covalent bonds, Fajan's rules, hydrogen bonding and its effect on physical and chemical properties; Coordinate bonding: Complex

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salts and double salts, Warner's theory of coordination, chelate complexes, stereochemistry of coordination numbers 4 and 6. IUPAC nomenclature of coordination complexes.

Principles of inorganic analysis (qualitative): Formation of sublimates; principle of flame test, borax-bead test, cobalt nitrate test, fusion test, chromyl chloride test; analytical reactions for the detection of nitrate, nitrite, halides, phosphate, arsenate, arsenite, sulphide, sulphate, borate, carbonate. Analytical reactions for the detection of Cr^{3+} , Fe^{3+} , Co^{3+} , Ni^{2+} , Cu^{2+} , As^{3+} , Mn^{2+} , Importance of common-ion effect in the separation of Group II cations, and Group III cations.

Bio-Inorganic Chemistry: An introduction to bio-inorganic chemistry, Role of metal ions present in biological systems with special reference to Na^+ , K^+ and Mg^{2+} ions, Na/K pump, Role of Mg^{2+} ions in energy production and chlorophyll, Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role.

Atomic Structure: Bohr's theory for hydrogen atom, atomic spectra of hydrogen and Bohr's model, Sommerfeld's model, quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, electronic configuration of many-electron atoms, Aufbau principle and its limitations.

Radioactivity and Nuclear Structure of Atoms: Natural & artificial radioactivity; radioactive disintegration series, group displacement law, law of radioactive decay, half-life of radio elements, Stability of atomic nucleus, n/p ratio, nuclear binding energy, mass defect, fission, fusion, transmutation of elements.

Chemical Periodicity: Classification of elements on the basis of electronic configuration, general characteristics of s-, p-, d- and f-block elements, position of hydrogen and noble gases, atomic and ionic radii, ionization potential, electron affinity, and electronegativity.

Gravimetric Analysis: Solubility product and common ion effect, Requirements of gravimetry, Gravimetric estimation of chloride, sulphate, lead, barium, nickel, copper and zinc.

Volumetric Analysis: Primary and secondary standard substances; principles of acid-base, oxidation – reduction and complexometric titrations; indicators: acid-base, redox and metal ion; principles of estimation of mixtures: NaHCO_3 and Na_2CO_3 (by acidimetry); iron, copper, manganese and chromium (by redox titration); zinc, aluminum, calcium and magnesium (by EDTA titration).

Chromatographic methods of analysis: column chromatography and thin layer chromatography.

Glass and Ceramics: Definition and manufacture of glasses, optical glass and coloured glass. Clay and feldspar, glazing and vitrification, glazed porcelain, enamel.

Portland cement: Composition and setting of cement, white cement.

Environmental Chemistry: The Atmosphere: Composition and structure of the atmosphere, troposphere, stratosphere, mesosphere and thermosphere. Ozone layer and its role. Major air pollutants : CO , SO_2 , NO and particulate matters –their origins and harmful effects, problems of ozone layer depletion, green house effect, acid rain and photochemical smog. Air pollution episodes. Air quality standard. Air pollution control measures: cyclone collector, electrostatic precipitator, catalytic converter. The Hydrosphere: Environmental

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role of water, natural water sources, water treatment for industrial, domestic and laboratory uses; water pollutants; action of soaps and detergents, phosphates, industrial effluents, agricultural runoff, domestic wastes; thermal pollution, radioactive pollution and their effects on animal and plant life; water pollution episodes: water pollution control measures : waste water treatment; chemical treatment and microbial treatment; water quality standards: DO, BOD, COD, TDS and hardness parameters; desalination of sea water : reverse osmosis, electrodialysis.

III. Physical Chemistry:

Gaseous & Liquid states: Gaseous State: Gas laws, kinetic theory of gas, collision and gas pressure, derivation of gas laws from kinetic theory, average kinetic energy of translation, Boltzmann constant and absolute scale of temperature, Maxwell's distribution law of molecular speeds, most probable, average and root mean square speed of gas molecules, principle of equipartition of energy, Mean free path and collision frequencies, Heat capacity of gases (molecular basis), viscosity of gases, Real gases, compressibility factor, deviation from ideality, van der Waals equation of state, critical phenomena, continuity of states, critical constants; Liquid state: physical properties of liquids and their measurements, surface tension and viscosity.

Chemical kinetics and catalysis: Order and molecularity of reactions, rate laws and rate equations for first order and second order reactions (differential and integrated forms); zero order reactions, Determination of order of reactions, Temperature dependence of reaction rate, energy of activation; Catalytic reactions: homogeneous and heterogeneous catalytic reactions, autocatalytic reactions, catalyst poisons, catalyst promoters (typical examples).

Thermodynamics: Intensive and extensive variables, isolated, closed and open systems, Cyclic, reversible and irreversible processes, Thermodynamic functions and their differentials, concept of heat (q) and work (w), First law of thermodynamics, internal energy (U) and enthalpy (H), relation between C_p and C_v , calculation of w, q, ΔU and ΔH for expansion of ideal gas under isothermal and adiabatic conditions for reversible and irreversible processes including free expansion; Joule-Thomson Coefficient and inversion temperature; Application of First law of thermodynamics, standard state, standard enthalpy; changes of physical and chemical transformations: fusion, sublimation, vaporization, solution, dilution, neutralization, ionization; Hess's law of constant heat summation; Bond-dissociation energy, Born haber cycle for calculation of lattice energy; Kirchhoff's equation, relation between ΔH and ΔU of a reaction, Spontaneous processes, heat engine, Carnot cycle and its efficiency, Second law of thermodynamics, Entropy (S) as a state function, molecular interpretation of entropy, entropy changes in simple transformations; Free energy: Gibbs function (G) and Helmholtz function (A), Gibbs-Helmholtz equation, criteria for thermodynamic equilibrium and spontaneity of a process.

Chemical equilibrium: Chemical equilibria of homogeneous and heterogeneous systems, temperature, pressure and concentration dependence of equilibrium constants (K_p , K_c , K_x); Le Chatelier's principle of dynamic equilibrium.

Colloids: colloids and crystalloids, classification of colloids, preparation and purification of colloids: ferric hydroxide sol and gold sol. Properties of colloids: Brownian motion, peptization, dialysis, Tyndal effect and its applications. Protecting colloids, gold number, isoelectric points, coagulation of colloids by electrolytes, Schulze-Hardy rule.

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Acids-bases and solvents: Modern aspects of acids and bases: Arrhenius theory , theory of solvent system, Bronsted and Lowry's concept, Lewis concept with typical examples, applications and limitations. Strengths of acids and bases (elementary idea). Ionization of weak acids and bases in aqueous solutions, application of Ostwald's dilution law, ionization constants, ionic product of water, pH-scale, buffer solutions and their pH values, buffer actions; hydrolysis of salts. Solutions of electrolytes: Electrolytic conductance, specific conductance, equivalent conductance and molar conductance of electrolytic solutions. Influence of temperature and dilution on weak electrolytes.