

# **Syllabus for Scientific Officer (Toxicology)**

## **(1) Chemistry**

### **Physical Chemistry :-**

Basic principles and applications of quantum mechanics – hydrogen atom, angular momentum.

Variational and perturbational methods.

Basics of atomic structure, electronic configuration, shapes of orbitals, hydrogen atom spectra.

Theoretical treatment of atomic structures and chemical bonding, chemical applications of group theory.

Basic principles and application of spectroscopy- rotational, vibrational, electronic, Raman, ESR, NMR.

Chemical thermodynamics.

Phase Equilibria.

Statistical Thermodynamics

Chemical equilibria.

Electrochemistry – Nernst equation, electrode kinetics, electrical double layer, Debye-Huckel theory.

Chemical Kinetics- empirical rate laws. Arrhenus equation, theories of reaction rates, determination of reaction mechanisms, experimental techniques for fast reactions.

Concept of catalysis.

Polymer chemistry, molecular weights and their determinations. Kinetics of chain polymerization.

Solids – Structural classification of binary and tertiary compounds, diffraction techniques, bonding, thermal, electrical and magnetic properties.

Colloids and surface phenomena.

Data analysis.

### **Inorganic Chemistry :**

Chemical Periodicity,

Structure and bonding in homo and hetero-nuclear molecules, including shapes of molecules.

Concepts of acids and bases.

Chemistry of the main group elements and their compounds, allotropy, synthesis, bonding and structure.

Chemistry of transition elements and coordination compounds, bonding theories.

Spectral and magnetic properties, reaction mechanisms.

Inner transition elements- spectra and magnetic properties, analytical application.

Organo-metallic compounds- synthesis, bonding and structure and reactivity, organo-metallics in homogenous catalysis, Cages and metal clusters.

Analytical Chemistry – Separation techniques, spectroscopic electro and thermo-analytical methods.

**Bioinorganic chemistry** – Photo-systems, porphyrines, metallo-enzymes, oxygen transport, electron transfer reactions, nitrogen fixation.

Physical characterization of inorganic compounds by IR Raman, NMR, EPR Mossbauer, UV, NOR, MS. Electron spectroscopy and microscopic techniques.

**Nuclear Chemistry** – Nuclear reactions, fission and fusion, radio analytical techniques and activation analysis.

### **Organic Chemistry –**

IUPAC nomenclature of organic compounds.

Principles of stereochemistry, conformational analysis, isomerism and chirality.

Reactive intermediates and organic reactions mechanisms.

Concepts of aromaticity.

Pericyclic reactions.

Named reactions.

Transformations and rearrangements.

Principles and applications of organic photochemistry. Free radical reactions.

Reactions involving nucleophilic carbon intermediates.

Oxidation and reduction of functional groups.

Common reagents (organic, inorganic and organo-metallic ) in organic synthesis.

Chemistry of natural products such as steroids, alkaloids, terpenes, peptides, carbohydrates, nucleic acids and lipids.

Selective organic transformations – Chemo-selectivity, regio-selectivity , stereo-selectivity , enantio-selectivity, protecting groups.

Chemistry of aromatic and aliphatic heterocyclic compounds.

Physical characterization of organic compounds by IR, UV,MS and NMR, GC-MS, and LC-MS.

### **Interdisciplinary topics.**

Chemistry in nano-science and technology.

Catalysis and green chemistry.

Medicinal chemistry.

Supramolecular chemistry.

Environmental chemistry.

Statistics.

Type of data, measure of central tendency, dispersion of data, correlation, probability and proof.

## **(2) Forensic Chemistry.**

### **Section A**

#### **Introduction of Forensic Science**

Definition and scope of forensic science, historical development of forensic Sciences, Basic principles of forensic science, crime scene management and investigation. Searching methods at scene of crime, sketching and photography, collections, preservation, packing and forwarding of physical evidence to the forensic science laboratory. Reconstruction of crime scene, physical evidences - types and importance. Legal and court procedure pertaining to expert testimony, organization and management of forensic science laboratory, Quality control Accreditation and credibility in forensic science laboratory, role of forensic scientist.

#### **Instrumentation-**

Microscope and its parts, function, application in forensic science. Types of microscopes, simple, compound, polarizing, phase contrast, comparison, stereo, fluorescence, electron. TEM and SEM principles, techniques and application in forensic science UV visible I.R. FTIR, Atomic absorption spectroscopy, mass spectrometry. Raman spectroscopy, Neutron activation analysis, N.M.R. x- ray analysis, x-ray diffraction analysis, X-ray fluorescence analysis. Thermal techniques- TGM and D.T.A. Chromatography – Theory and techniques, column, Paper, TLC, ion exchange. GC, HPLC, HPTLC, CG-MS and LC-MS. Theory and principles. High and Low Voltage electrophoresis, gel electrophoresis. Immune electrophoresis, Iso electrophoresis.

#### **Forensic statistics**

Type of data, measure of central tendency, dispersion of data, correlation, probability and proof.

Psychological techniques in forensic science.

Polygraph, Narcoanalysis, brain mapping, hypnosis and their legal status.

### **Wild life forensics.**

Wild life species, identification methods, significance of pug marks in wild life identification, importance of DNA techniques in poaching cases. Wild life DNA data bank and its utility.

### **Computer Forensics**

Introduction to computer and cyber crimes – hacking, Virus, Phising, pornography, software piracy, program manipulation, ATM frauds, role of forensic scientist in computer crime investigation and prevention.

### **Section B**

#### **Forensic Chemistry**

Definition and scope, preliminary screening methods for some chemical constituents. Spot test and crystal test.

Analysis of Toxic anions – Nitric, Nitrate, Sulphide, Sulphate, Halides, Cyanide.

Analysis of CO<sub>2</sub> and CO. Analysis of some metallic poisons – As, Sb, Pb, Ba, Cu, Hg, Zn, Thallium.

Analysis of Methanol, Ethanol, Denatured spirit, illicit liquor.

Methanol Poisoning.

Analysis of ethyl alcohol in breath, blood and urine.

Analysis of Dyes and pigments.

Determination of adulteration in edible oils, food commodities, fertilizers, cement, ornaments.

Alkaloid -

Definition, classification, isolation and general properties. Examination of morphine, codeine, brucine, strychnine, atropine, heroin, cocaine, alkaloids from opium, cannabis sativa and Dhatura.

## **Fire and Arson investigation**

Nature and chemistry of fire, types of arson cases, detailed examination of scene of crime, collection and preservation of evidences in a arson case, analysis of incendiary material from debris . Analysis of petroleum products for adulteration. Trap cases- analysis of Dyes used in trap cases.

## **Explosive**

Nature, classification and composition, ignition, combustion and detonation. Examination of explosives, Bomb and LED (Improved explosive device) Reconstruction of explosive cases, Diffusing of Live Bomb, analysis of cement and Mortar analysis of Detergent and Soap.

## **(3) FORENSIC TOXICOLOGY**

### **SECTION- A**

#### **INTRODUCTION OF FORENSIC SCIENCE**

Definition and scope of Forensic Science, Historical development of forensic science. Basic principle of Forensic Science, crime scene management and investigation, searching methods at scene of crime, sketching and photography collection preservation packing and forwarding of physical evidence to forensic science laboratory. Reconstruction of crime scene, physical evidences, types and Importance legal and court procedure pertaining to expert testimony, organization and management of forensic science laboratory. Quality control, accreditation and credibility in forensic science laboratory. Role of forensic scientist.

#### **INSTRUMENTATION**

Microscope and its parts, function, application in forensic science

Type of microscope- simple, compound, polarising, phase contrast, comparison, stereo, fluorescence, Electron- TEM and SEM,

Principles, techniques and application in forensic science- UV Visible, I.R. FTIR Atomic absorption spectroscopy. Mass spectrometry Raman spectroscopy. Neutron Activation Analysis, N.M.R. X-Ray analysis, X-Ray Diffraction analysis. X-Ray

fluorescence analysis. Thermal Techniques- TGM and D.T.A Chromatography, Theory and techniques- column, paper, TLC, Ion exchange, GC,HPLC,HPTLC, CG-MS and LC-MS. Theory and principles. High and low voltage electrophoresis. Gel Electrophoresis, Immune Electrophoresis, Iso-electrophoresis.

### **Forensic statistics**

Type of data, measure of central tendency, dispersion of data, correlation, probability and proof.

### **Psychological Techniques in forensic science.**

Polygraph, Narco-analysis, Brain Mapping, Hypnosis and their legal status.

### **Wild life forensic**

Wild life species identification methods. Significance of pug mark in wild life identification, importance of DNA technique in poaching case Wild life DNA Data Bank and its utility.

### **Computer Forensic**

Introduction to computer and cyber crime- Hacking, Virus, Phising, Pornography, software piracy, program manipulation, ATM Frauds. Role of Forensic scientist in computer crime investigation and prevention.

### **Section B**

Forensic Toxicology

Definition and Scope

#### **Poison**

Definition, classification, Mode of action, factors modifying mode of action of poison.

Methods of Poison administration, toxicological exhibits in poisoning cases, their collection and preservation. Extraction and isolation of poison from viscera and other biological specimen. Analysis of corrosive and irritant poisons.

**Metallic Poisons** -As, Sb, Pb, Hg, Cu, Ba, Zn, Th and their examination in laboratory.

**Analysis of Toxic Anions**

Nitrite, Nitrate, Sulphide, Sulphate, Halides, Phosphide, cyanide

Estimation of liquor in breath, blood and urine.

Analysis of methanol, ethanol, Acetone, chloroform, ether, Denatured spirit and Methanol poisoning, analysis of CO<sub>2</sub> and CO and other Poisonous gases.

Insecticide and Pesticide.

Organochloro, organophosphorous and carbamates and their analysis .

Alkaloids – Definition, classification, isolation and general properties.

Analysis of Morphine, codeine, Brucine, strychnine, Nicotine, atropine, hyosyamine, Cocaine.

**Plant Poisons and their examination**

Datura, Papaver somniferum, atropa belladonna, Marking nut, Nux vomica, oleander, Aconite, abrus, cannabis sativa, Coca, croton, snake venom and canthridine.

Analysis of Barbiturates, Chloral hydrate, tranquilizers.

Examination of Heroine, Methaquinol, Meprabonate. Mescaline Mandrax, LSD, Amphetamine, Benzodiazepines. Abusive drugs used in Sports.

Food Poisoning, Botulism, Ptomaine poisoning.