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Syllabus for Recruitment Examination of  
Post Graduate Teacher (Chemistry)

**PAPER-I**

**Unit 1:- Co-ordination compounds and Organo- Metallics**

Introduction, definition of co-ordination compounds, co-ordination Number, Werner's co-ordination theory, ligands and their types, IUPAC- nomenclature of co-ordination compounds, Isomerism, bonding in co-ordination compounds: valence bond theory and crystal field theory, Colour and magnetic properties in co-ordination compounds, biological importance of co-ordination compounds. Organo-Metallics : Types and nomenclature. Metal carbonyls, its preparation, properties and uses. Grignard reagents.

**Unit 2 :-Concept of organic chemistry**

Hybridisation of carbon in organic compounds, sigma and pi-bonds, shapes of simple organic molecules, structural and geometrical isomerism, optical isomerism of compounds containing up to two asymmetric centres (EZ concept excluded) IUPAC- nomenclature of simple organic compounds with different functional groups, conformations in Ethane and Butane (Newman and Projections), chain and Boat forms of cyclohexane, Resonance and hyperconjugation, keto- enol tautomerism determination of empirical and molecular formula of simple compound (only combustion method) hydrogen bonds- definition and their effect on physical properties of alcohol and carboxylic acids, inductive and resonance effect on acidity and basicity of organic acids and bases polarity and inductive effect in alkyl halides, reactive intermediate produced during homolytic and heterolytic bond cleavage: formation, structure and stability of carbocations, carbanions and free radicals

**Unit 3:-Hydrocarbons**

Nature and classification of hydrocarbons (aliphatic and aromatic), IUPAC nomenclature. Alkanes: Preparation, physical properties and chemical reactions including free radical mechanism halogenation, combustion and pyrolysis, isomerism in alkanes. Alkenes and Alkynes: Structure of double bonds (in alkenes) and triple bonds (in alkynes), geometrical isomerism in alkenes, Preparation, properties and reactions of alkenes and alkynes, addition of hydrogen, halogens, water, hydrogen halides (Markovnikov's rule and peroxide effect). Mechanism of electrophilic addition, acidic nature of alkenes and alkynes, reaction of alkenes with potassium permanganate, ozonolysis of alkenes and alkynes, Alkadienes, its classification, preparation of conjugate dienes. Benzene: Resonance, aromaticity, Chemical properties, Electrophilic substitution of Benzene (Halogenation, Nitration,



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Sulphonation, Friedel–craft alkylation and acylation), effect of ortho, meta, para directing group in monosubstituted benzene, Benzene; Carcinogenic nature and toxicity.

#### Unit 4:- Haloalkanes and Haloarenes

Introduction, classification of Halogen derivatives of hydrocarbons as aliphatic halogen compounds, nature of carbon atoms, classification on the basis of type of hybridization of carbon bonded to the halogen atom, Nomenclature of haloalkanes and haloarenes, isomerism in haloalkanes and haloarenes, methods of preparation, properties(physical and chemical) of haloalkanes and haloarenes, test to distinguish alkylhalides and arylhalides, mechanism and definition of  $SN^2$  and  $SN^1$  reaction. Reactivity of alkyl halides towards  $SN^2$  reaction and  $SN^1$  reaction, some basic concept about optical activity and optical isomerism, stereo- chemical aspects of nucleophilic substitution reaction of  $SN^2$  and  $SN^1$ , uses and environment effect of dichloromethane, trichloromethane, tetrachloromethane, iodoform, freons DDT.

#### Unit 5:- Alcohols, Phenols and Ethers

**Alcohols:** Nomenclature, nature of C-O bond, physical and chemical properties, mechanism of substitution reaction, mechanism of dehydration, uses. Some important compound(methanol and ethanol), Identification of primary, secondary and tertiary alcohol. Phenols: its nomenclature, method of preparation, physical and chemical properties, acidic nature of phenol, electrophilic substitution reaction, uses of phenols, Kolbe's and Reimer – Tieman reactions.

**Ether :-** Its nomenclature, methods of preparation, physical and chemical properties, uses.

#### Unit 6:-Aldehydes, Ketones and Carboxylic Acids

**Aldehydes and Ketones :-** Their nomenclature, isomerism, methods of their preparation (common as well as individual preparation) physical properties and chemical properties Aldol condensation, Cannizzaro reaction, Rosemund's reduction, Clemmensen reduction Perkin reaction. Relative reactivity of Aldehydes and Ketones, uses of formaldehyde, acetaldehyde, acetone and benzaldehydes, distinction between aldehydes and ketones Gatterman- Koch reaction, Etard reaction, Stephen reaction, Wolff-Kishner reduction, acidity of  $\alpha$  hydrogen's of aldehydes and ketones, (aldol condensation).

**Carboxylic Acids :-** Its nomenclature, structure of carboxyl group, methods of preparation physical and chemical properties and uses of Carboxylic acids. Acidity and effect of substituent's on acid strength of carboxylic acids. Derivatives of carboxylic acid (Anhydride, acid chloride, amide and ester): preparation, properties and uses



**Unit 7:- Amines:** Nomenclature, classification (aliphatic and aromatic) structure, preparation, physical and chemical properties, diazonium salts: preparation, properties, displacement of nitrogen and retention properties and uses; distinction i.e. test for amines (Primary, Secondary and tertiary), use of diazo group, Sandmeyer reaction, Gatterman reaction, Balz-Schiemann reaction. Coupling reaction, importance of diazonium salts in synthetic organic chemistry

### **Unit 8:- Polymers**

Introduction, classification of polymers, types of polymerization reaction, classification based on sources of availability, upon structure upon molecular forces and mode of synthesis, uses of various types of polymers, molecular forces and mode of synthesis, use of various types of polymers, molecular masses of polymers, polydispersity index (PDI) Biodegradable polymers.

### **Unit 9 :- Chemistry in Everyday Life**

Introduction, chemistry used in medical science- Drugs, designing of drugs, classification of drugs, interaction of drug with targets, receptor as drug target types of drug as antipyretics, analgesics, antiseptics, disinfectants, tranquilizers, antibiotic (narrow and broad spectrum), antifertility drugs, antihistamines and antacids; Chemicals in food, food preservatives, artificial sweetening agents, cleansing agents- Soaps and Detergents, classification of detergents, advantages of synthetic detergents over soaps.

### **Unit 10:- Biochemistry:-**

Introduction, Carbohydrates: different way of classification, monosaccharides- structural determination of glucose and fructose on the basis of their chemical properties, Open chain structure Haworth structure, D-L configuration, mutarotation, anomers, chemical reactions of glucose, reducing and non-reducing sugar, oligosaccharides (sucrose, lactose, maltose), polysaccharides (starch, cellulose, glycogen). Proteins and amino acids, peptide bond, primary secondary and globular protein, nucleic acids, structure of DNA, nucleosides, biological function of nucleic acids, denaturation of proteins, photosynthesis, vitamins- classification and functions, diseases caused by the deficiency of vitamins, enzymes and its action mechanism, hormones.

### **Unit 11:- Practical Organic Chemistry**

Detection of elements (N, S, halogens), detection and identification of functional groups; hydroxyl (alcoholic and Phenolic), carbonyl (aldehyde and ketone), carboxylic, amino and nitro, chemical methods of separation of mono-functional organic compound from binary mixture.



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**Unit 12 :- Chemical Bonding and Molecular structure**

valance electrons, ionic bonds, covalent bond, bond parameters, Lewis structure, polar character of covalent bond, covalent character of ionic bond, co-ordinate bond, valence bond theory, resonance, geometry of covalent molecule, VSEPR theory; shapes of some simple molecules, concept of hybridization involving s,p and d-orbitals and molecular orbit theory (homonuclear diatomic molecules only, qualitative idea only), hydrogen bond, polarity in covalent bond and dipole moment of covalent compound.

**Unit 13:- Environment Chemistry**

Different types of pollution, acids rain, ozone layer depletion, green house effect and global warming, pollution due to industrial wastes, green chemistry as an alternative tool for reducing pollution, strategy for control of environment pollution.

**PAPER-II**

**Unit I:-Some Basic Concepts of Chemistry**

General introduction: importance and scope of chemistry. Historical approach to particular nature of matter, laws of chemical combination, Dalton's atomic theory: concept of elements, atoms and molecules. Atomic and molecular masses, mole concept and molar mass, percentage composition, empirical and molecular formula, chemical reaction, Stoichiometry, concept of limiting reagent, S.I system of unit, properties of matter and their measurement uncertainty in measurement. Equivalent mass (acids, bases and salts)

**Unit II: - States of Matter**

Gas, Liquid and solid; Types of intermolecular forces. Gaseous state: the laws governing ideal gas behaviour, Dalton's law of partial pressure, kinetic molecular theory of gases, Maxwell-Boltzmann distribution law of molecular motion, real gases - deviation from ideal behavior, equation of state. Liquids and their properties (vapour pressure and viscosity). Classification of solids based on different binding forces; molecular, ionic, covalent and metallic solids, crystalline and amorphous solids, unit cell in two and three dimensional lattices, calculation of density of unit cell. Packing in solids packing efficiency, voids, number of atoms per unit cell in different cubic lattices, point defects in solids, electric and magnetic properties in solid.

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**Unit III:- Structure of Atom**

Discovery of electron, proton and neutron; atomic number, isotopes and isobars. Rutherford's model and its limitations, Bohr's model and its limitations, dual nature of matter and light, de Broglie's relationship, Black body radiation, Planks constant, Heisenberg uncertainty principle, wave mechanical model of the hydrogen atom quantum mechanical model of atom, Schrödinger equation, wave function,



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concept of orbitals, quantum numbers, shapes of *s*, *p* and *d* orbitals, rules for filling electrons in orbitals - Aufbau principle, Pauli exclusion principle and Hund's rule, electronic configuration of atoms, stability of half filled and completely filled orbitals.

#### **Unit IV:- Equilibrium**

Equilibrium in physical and chemical processes,, dynamic nature of equilibrium, Law of mass action, equilibrium constant ( $K_c$  and  $K_p$ ), Le Chatelier's principle (effect of concentration , temperature and pressure ), ionic equilibrium, ionization of acids and bases, strong and weak electrolytes, degree of ionization, solubility product, common ion effect, PH and buffer solution, Acid and Bases (Bronsted-Lowry and Lewis concept), Hydrolysis of salts, Homogeneous and Heterogeneous Equilibria, Application of equilibrium constants: relationship between Equilibrium Constant- $K$ , Reaction Quotient- $Q$  and Gibb's Energy- $G$

#### **Unit V:- Surface chemistry**

Adsorption –physisorption and chemisorptions; factor affecting adsorption of gases on solids; catalysis: homogeneous and heterogeneous activity and selectivity: enzyme catalysis; colloidal state: distinction between true solutions, colloids and suspensions; Classification of colloids: lyophobic and lyophilic colloidal solution, multimolecular and macromolecular colloids, Preparation and properties of colloidal solution; Tyndall effect, Brownian movement, electrophoresis, coagulation; emulsion: types of emulsion its preparation, properties and uses, uses of adsorption, uses of homogeneous and heterogeneous catalysts.

#### **Unit VI:- Chemical Kinetics – Theories of Reaction**

Rate of a reaction (average and instantaneous), factors affecting rates of reaction: concentration, temperature, catalyst; order and molecularity of a reaction; rate law and specific rate constant, integrated rate equations and half life (only for zero and first order reactions); concept of collision theory (elementary idea, no mathematical treatment). Activation energy, Arrhenius equation, reaction mechanism (simple reaction only).

#### **Unit:-VII Electrochemistry**

Concept of oxidation and reduction, redox reactions, oxidation number, conductance in electrolytic solution, specific and molar conductivity, variation of conductivity with concentration. Kohlrausch's law, electrolysis and law of electrolysis, electrochemical cells and cell reaction, standard electrode potentials, NHE, electrochemical series, Nernst equation and its application to chemical cells, Galvanic cells, concentration cells, fuel cells ,batteries, corrosion.



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**Unit:- VIII Solution**

Solution and its types, expression of concentration of solution of solid in liquid, solubility of gases in liquid, solid solution, Raoult's laws, Raoult's law as specific case of Henry's law. ideal and non-ideal solution, colligative properties (lowering of vapour pressure, elevation in Boiling point, depression of freezing point, osmotic pressure), colligative properties and determination of molar Mass, Abnormal Molecular Masses.

**Unit X:- Thermodynamics**

Concept of system, types of system, surrounding, work heat energy, extensive and intensive properties, state function, first law of thermodynamics, internal energy and enthalpy, heat capacity and specific heat, measurement of  $\Delta U$  and  $\Delta H$ , Hess's law of constant heat summation, Enthalpy of: Bond dissociation, combustion, formation, atomization, sublimation, phase transition, ionization and dilution, concept of entropy, second law of Thermodynamics, Free Energy: Gibbs energy; criterion of spontaneity, free energy and chemical equilibrium, third law of thermodynamic.

**Unit XI:- Classification of Elements and Periodicity in properties**

Signification of classification, history of the development of periodic table, Mendeleev's periodic law and periodic table, modern periodic law and long form of periodic table, periodic trends in properties of elements (atomic radii, ionic radii, inert gas radii, ionization enthalpy, electron gain enthalpy, electronegativity, metallic property, valency). Determination of position of element in periodic table. IUPAC Nomenclature of elements with atomic number 100 onwards.

**Unit XII :- Hydrogen and S- Block Elements**

Position of hydrogen in periodic table, occurrence, isotopes, preparation properties and uses of hydrogen, hydrides (ionic covalent and interstitial) physical and chemical properties of water, hardness of water: causes of hardness and types, removal of hardness, heavy water, hydrogen peroxide: preparation, reaction and structure, hydrogen as a fuel.

Alkali and Alkaline earth metals: general introduction of s- & p-block elements, electronic configuration, occurrence, anomalous properties of the first element of each group, diagonal relationship, trends in the variation of properties (such as ionization enthalpy, atomic and ionic size), trends in chemical reactivity with oxygen, water, hydrogen and halogens. Uses of these metals.

**Unit XIII:- P-Block Elements**

General introductions of p-block elements

Group -13 elements :- General introduction, electronic configuration, occurrence, variation of properties, oxidation states, trends in chemical reactivity, anomalous behaviours of first element of the group; Boron physical and chemical properties.



some important compounds: borax, boric acids, boron hydrides. Aluminium: uses, reactions with acids and bases.

Group -14 elements :- General introduction, electronic configuration, occurrence, variation of properties, oxidation states, trends in chemical reactivity, anomalous behaviour of first element. Carbon - catenation, allotropic forms, physical and chemical properties; uses of some important compounds: oxides. Important compounds of silicon and a few uses : silicon tetrachloride, silicones, silicates and zeolites, their uses.

Group -15 elements :- General introduction, electronic configuration, occurrence, oxidation states, trends in physical and chemical properties and used, compound of nitrogen, preparation and properties of ammonia and nitric acid, oxides of phosphorous- preparation and properties of phosphine, halides ( $\text{PCl}_3$  and  $\text{PCl}_5$ ) and oxoacids

Group 16- Elements :- General introduction, electronic configuration, oxidation states, occurrence, trends in physical and chemical properties; dioxygen: preparation, properties and uses; classification of oxides; ozone. Sulphur – allotropic forms; compounds of sulphur: preparation, properties and uses of sulphur dioxide; sulphuric acid: industrial process of manufacture, properties and uses, oxoacids of sulphur (structures only).

Group- 17 Elements :- General introduction, electronic configuration, oxidation states, occurrence, trends in physical and chemical properties; compounds of halogens: preparation, properties and uses of chlorine and hydrochloric acid, interhalogen compounds, oxoacids of halogens (structures only).

Unit -18 elements :- General introduction, electronic configuration occurrence, trends in physical and chemical properties uses.

**Unit XIV:- The d and f- Block Elements** General introduction ,electronic configuration, occurrence and characteristics of transition metals, general trends in properties of the first row transition metals – metallic character, ionization enthalpy, oxidation states, ionic radii, colour, catalytic property, magnetic properties, interstitial compounds, alloy formation. Preparation and properties of  $\text{K}_2\text{Cr}_2\text{O}_7$  and  $\text{KMnO}_4$ .

*Lanthanoids* – electronic configuration, oxidation states, chemical reactivity and lanthanoid contraction and its consequences.

*Actinoids* – Electronic configuration, oxidation states and comparison with lanthanoids. General introduction, electronic configuration, occurrence and characteristics of transition metal, general trends in properties of the first row transition metal- metallic character, ionization enthalpy, oxidation states, ionic radii, colour, catalytic properties ,magnetic properties ,interstitial compounds. Alloy formation, preparation and properties of  $\text{K}_2\text{Cr}_2\text{O}_7$  and  $\text{KMnO}_4$ .lanthanoids–electronic configuration, oxidation state, chemical reactivity and lanthaniod contraction. actinoids –electronic configuration and oxidation states.