SyllabusforJEE (Main)-2024

SyllabusforJEEMainPaper1(B.E./B.Tech.)- CHEMISTRY

PHYSICALCHEMISTRY

UNITI: SOMEBASICCONCEPTS IN CHEMISTRY

Matter and its nature, Dalton's atomic theory: Concept of atom, molecule, element, and compound:: Laws of chemical combination; Atomic and molecular masses, mole concept, molar mass, percentage composition, empirical and molecular formulae: Chemical equations and stoichiometry.

UNIT2:ATOMICSTRUCTURE

Natureofelectromagneticradiation,photoelectriceffect;Spectrumofthehydrogenatom.Bohr model of a hydrogen atom - its postulates, derivation of the relations for the energy of the electronandradiiofthedifferentorbits,limitationsofBohr'smodel;Dualnatureofmatter,de Broglie's relationship. Heisenberg uncertainty principle. Elementary ideas of quantum mechanics,quantummechanics,thequantummechanicalmodeloftheatom,anditsimportant features. Concept of atomic orbitals as one-electron wave functions: Variation of Ψ and Ψ^2 with r for 1s and 2s orbitals; various

quantum numbers (principal, angular momentum, and magnetic quantum numbers) and their significance; shapes of s, p, and d - orbitals, electron spin, and spin quantum number: Rules forfillingelectronsinorbitals–Aufbauprinciple.Pauli'sexclusionprincipleandHund'srule, electronic configuration of elements, and extra stability of half-filled and completely filled orbitals.

UNIT3:CHEMICALBONDINGANDMOLECULARSTRUCTURE

Kossel-Lewisapproachtochemicalbondformation,theconceptofionic andcovalentbonds.

Ionic Bonding: Formation of ionic bonds, factors affecting the formation of ionic bonds; calculation of lattice enthalpy.

Covalent Bonding: Concept of electronegativity. Fajan’s rule, dipole moment: Valence Shell Electron Pair Repulsion (VSEPR) theory and shapes of simple molecules.

Quantum mechanical approach to covalent bonding: Valence bond theory - its important features, the concept of hybridization involving s, p, and d orbitals; Resonance.

Molecular Orbital Theory - Its important features. LCAOs, types of molecular orbitals (bonding, antibonding), sigma and pi-bonds, molecular orbital electronic configurations of homonuclear diatomic molecules, the concept of bond order, bond length, and bond energy.

Elementaryideaof metallicbonding.Hydrogen bonding and its applications.

UNIT4:CHEMICALTHERMODYNAMICS

Fundamentals of thermodynamics: System and surroundings, extensive and intensive properties, state functions, Entropy, types of processes.

Thefirstlawofthermodynamics -Conceptofwork,heatinternal energyandenthalpy,heat capacity,molarheatcapacity;Hess’slawofconstantheatsummation;Enthalpiesofbond

dissociation, combustion, formation, atomization, sublimation, phase transition, hydration, ionization, and solution.

The second law of thermodynamics - Spontaneity of processes; ΔS of the universe and ΔG ofthesystemascriteriaforspontaneity.ΔG°(StandardGibbsenergychange)andequilibrium constant.

UNIT 5: SOLUTIONS

Different methods for expressing the concentration of solution - molality, molarity, mole fraction,percentage(byvolumeandmassboth),thevapourpressureofsolutionsandRaoult's Law - Ideal and non-ideal solutions, vapour pressure - composition, plots for ideal and non- ideal solutions; Colligative properties of dilute solutions - a relative lowering of vapour pressure, depression of freezing point, the elevation of boiling point and osmotic pressure; Determinationofmolecularmassusingcolligativeproperties;Abnormalvalueofmolarmass, Van't Hoff factor and its significance.

UNIT 6: EQUILIBRIUM

Meaningofequilibrium istheconceptofdynamic equilibrium.

Equilibria involving physical processes: Solid-liquid, liquid-gas - gas and solid-gas equilibria, Henry's law. General characteristics of equilibrium involving physical processes.

Equilibrium involving chemical processes: Law of chemical equilibrium, equilibrium constants ($K_p$and K_c) and their significance, the significance of ΔG and ΔG° in chemical equilibrium, factors affecting equilibrium concentration, pressure, temperature, the effect of catalyst; Le Chatelier's principle.

Ionic equilibrium: Weak and strong electrolytes, ionization of electrolytes, various concepts of acids and bases (Arrhenius. Bronsted - Lowry and Lewis) and their ionization, acid-base equilibria (including multistage ionization) and ionization constants, ionization of water. pH scale, common ion effect, hydrolysis of salts and pH of their solutions, the solubility of sparingly soluble salts and solubility products, and buffer solutions.

UNIT7:REDOXREACTIONSAND ELECTROCHEMISTRY

Electronic concepts of oxidation and reduction, redox reactions, oxidation number, rules for assigning oxidation number, and balancing of redox reactions.

Electrolytic and metallic conduction, conductance in electrolytic solutions, molar conductivities and their variation with concentration: Kohlrausch's law and its applications.

Electrochemicalcells-ElectrolyticandGalvaniccells,differenttypesofelectrodes,electrode potentialsincludingstandardelectrodepotential,half-cellandcellreactions,emfofaGalvanic cell and its measurement: Nernst equation and its applications; Relationship between cell potential and Gibbs' energy change: Dry cell and lead accumulator; Fuel cells.

UNIT8:CHEMICALKINETICS

Rateofachemicalreaction,factorsaffectingtherateofreactions:concentration,temperature, pressure,andcatalyst;elementaryandcomplexreactions,orderandmolecularityofreactions, ratelaw,rateconstantanditsunits,differentialandintegralformsofzeroandfirst-order

reactions,theircharacteristicsandhalf-lives,theeffectoftemperatureontherateofreactions, Arrheniustheory,activationenergyanditscalculation,collisiontheoryofbimoleculargaseous reactions (no derivation).

INORGANICCHEMISTRY

UNIT 9:CLASSIFICATIONOFELEMENTSANDPERIODICITYIN PROPERTIES

Modem periodic law and present form of the periodic table, s, p. d and f block elements, periodic trends in properties of elements atomic and ionic radii, ionization enthalpy, electron gain enthalpy, valence, oxidation states, and chemical reactivity.

UNIT10: P-BLOCK ELEMENTS

Group-13 toGroup18Elements

General Introduction: Electronic configuration and general trends in physical and chemical properties of elements across the periods and down the groups; unique behaviour of the first element in each group.

UNIT11: d -and f-BLOCK ELEMENTS

Transition Elements

General introduction, electronic configuration, occurrence and characteristics, general trends in properties of the first-row transition elements - physical properties, ionization enthalpy, oxidation states, atomic radii, colour, catalytic behaviour, magnetic properties, complex formation, interstitial compounds, alloy formation; Preparation, properties, and uses of $K_2Cr_2O_7$, and $KMnO_4$.

InnerTransition Elements

Lanthanoids-Electronicconfiguration,oxidationstates,andlanthanoidcontraction.

Actinoids-Electronicconfigurationandoxidationstates.

UNIT12:CO-ORDINATIONCOMPOUNDS

Introduction to coordination compounds. Werner's theory; ligands, coordination number, denticity. chelation; IUPAC nomenclature of mononuclear co-ordination compounds, isomerism;Bonding-ValencebondapproachandbasicideasofCrystalfieldtheory,colourand magnetic properties; Importance of co-ordination compounds (in qualitative analysis, extraction of metals, and in biological systems).

ORGANICCHEMISTRY

UNIT13:PURIFICATIONANDCHARACTERISATIONOFORGANICCOMPOUNDS

Purification - Crystallization, sublimation, distillation, differential extraction, and chromatography - principles and their applications.

Qualitativeanalysis-Detectionofnitrogen,sulphur,phosphorus,andhalogens.

Quantitative analysis (basic principles only) - Estimation of carbon, hydrogen, nitrogen, halogens, sulphur, and phosphorus.

Calculations of empirical formulae and molecular formulae: Numerical problems in organic quantitative analysis,

UNIT14:SOMEBASIC PRINCIPLESOFORGANICCHEMISTRY

Tetravalency of carbon: Shapes of simple molecules - hybridization (s and p): Classification of organic compounds based on functional groups: and those containing halogens, oxygen, nitrogen, and sulphur; Homologous series: Isomerism - structural and stereoisomerism.

Nomenclature(TrivialandIUPAC)

Covalentbondfission-Homolyticandheterolytic:freeradicals,carbocations,andcarbanions; stability of carbocations and free radicals, electrophiles, and nucleophiles.

Electronicdisplacementinacovalentbond

-Inductiveeffect,electromericeffect, resonance,andhyperconjugation.

Commontypesoforganicreactions-Substitution,addition,elimination,andrearrangement.

UNITS15:HYDROCARBONS

Classification, isomerism, IUPAC nomenclature, general methods of preparation, properties, and reactions.

Alkanes - Conformations: Sawhorse and Newman projections (of ethane): Mechanism of halogenation of alkanes.

Alkenes-Geometricalisomerism:Mechanismofelectrophilicaddition:additionofhydrogen, halogens, water, hydrogen halides (Markownikoffs and peroxide effect): Ozonolysis and polymerization.

Alkynes - Acidic character: Addition of hydrogen, halogens, water, and hydrogen halides: Polymerization.

Aromatichydrocarbons-Nomenclature,benzene-structureandaromaticity:Mechanismof electrophilic substitution: halogenation, nitration.

Friedel-Craft's alkylation and acylation, directive influence of the functional group in mono-substituted benzene.

UNIT16:ORGANICCOMPOUNDSCONTAINING HALOGENS

General methods of preparation, properties, and reactions; Nature of C-X bond; Mechanisms of substitution reactions.

Uses;Environmentaleffectsofchloroform,iodoformfreons,andDDT.

UNIT17:ORGANICCOMPOUNDSCONTAINING OXYGEN

Generalmethodsofpreparation,properties,reactions,anduses.

ALCOHOLS,PHENOLS,ANDETHERS

Alcohols: Identification of primary, secondary, and tertiary alcohols: mechanism of dehydration.

Phenols: Acidic nature, electrophilic substitution reactions: halogenation. nitration and sulphonation. Reimer - Tiemann reaction.

Ethers: Structure.

Aldehyde and Ketones: Nature of carbonyl group; Nucleophilic addition to >C=O group, relative reactivities of aldehydes and ketones; Important reactions such as - Nucleophilic addition reactions (addition of HCN. NH_3, and its derivatives), Grignard reagent; oxidation: reduction (Wolf Kishner and Clemmensen); the acidity of α-hydrogen. aldol condensation, Cannizzaro reaction. Haloform reaction, Chemical tests to distinguish between aldehydes and Ketones.

CarboxylicAcids

Acidicstrengthandfactorsaffectingit,

UNIT18:ORGANICCOMPOUNDSCONTAININGNITROGEN

Generalmethodsofpreparation.Properties,reactions,anduses.

Amines: Nomenclature, classification structure, basic character, and identification of primary, secondary, and tertiary amines and their basic character.

DiazoniumSalts: Importanceinsyntheticorganicchemistry.

UNIT19:BIOMOLECULES

Generalintroductionand importanceofbiomolecules.

CARBOHYDRATES - Classification; aldoses and ketoses: monosaccharides (glucose and fructose)andconstituentmonosaccharidesofoligosaccharides(sucrose,lactose,andmaltose).

PROTEINS - Elementary Idea of α-amino acids, peptide bond, polypeptides. Proteins: primary, secondary, tertiary, and quaternary structure (qualitative idea only), denaturation of proteins, enzymes.

VITAMINS–Classificationandfunctions. NUCLEICACIDS–

ChemicalconstitutionofDNAandRNA. Biological functions of

nucleic acids.

Hormones(General introduction)

UNIT20:PRINCIPLESRELATEDTOPRACTICALCHEMISTRY

Detectionofextraelements(Nitrogen,Sulphur,halogens)inorganiccompounds;Detectionof the following functional groups; hydroxyl (alcoholic and phenolic), carbonyl (aldehyde and ketones) carboxyl, and amino groups in organic compounds.

- Thechemistryinvolvedinthepreparationofthefollowing:

  Inorganic compounds; Mohr's salt, potash alum.

Organiccompounds:Acetanilide,p-nitroacetanilide,anilineyellow,iodoform.

- The chemistry involved in the titrimetric exercises – Acids, bases, and the use of indicators, oxalic-acid vs $KMnO_4$, Mohr's salt vs $KMnO_4$
- Chemical principles involved in the qualitative salt analysis:

  Cations–Pb^{2+},Cu^{2+},Al^{3+},Fe^{3+},Zn^{2+},Ni^{2+},Ca^{2+},Ba^{2+},Mg^{2+},NH_4^+

  Anions-CO_3^{2-},S^{2-},SO_4^{2-},NO_3^-,NO_2^-,Cl^-,Br^-,I^-(Insolublesaltsexcluded).

  Chemicalprinciplesinvolvedinthefollowingexperiments:

  1. Enthalpy ofsolution of$CuSO_4$
  2. Enthalpyofneutralizationofstrongacid andstrong base.
  3. Preparationoflyophilicandlyophobicsols.
  4. Kineticstudy ofthereaction ofiodideionswith hydrogen peroxideat room temperature.