# BITSAT EXAMINATION SYLLABUS PART – II CHEMISTRY

## 1. States of Matter

1.1 Measurement: Physical quantities and SI units, Dimensional analysis, Precision, Significant figures.
1.2 Chemical reactions: Laws of chemical combination, Dalton's atomic theory; Mole concept; Atomic, molecular and molar masses; Percentage composition & molecular formula; Balanced chemical equations & stoichiometry
1.3 Gaseous state: Gas Laws, Kinetic theory – Maxwell distribution of velocities, Average, root mean square and most probable velocities and relation to temperature, Diffusion; Deviation from ideal behaviour – Critical temperature, Liquefaction of gases, van der Waals equation.
1.4 Liquid state: Vapour pressure, surface tension, viscosity.
1.5 Solid state: Classification; Space lattices & crystal systems; Unit cell – Cubic & hexagonal systems; Close packing; Crystal structures: Simple AB and AB2 type ionic crystals, covalent crystals – diamond & graphite, metals. Imperfections- Point defects, non-stoichiometric crystals; Electrical, magnetic and dielectric properties; Amorphous solids – qualitative description.

## 2. Atomic Structure

2.1 Introduction: Subatomic particles; Rutherford's picture of atom; Hydrogen atom spectrum and Bohr model.
2.2 Quantum mechanics: Wave-particle duality – de Broglie relation, Uncertainty principle; Hydrogen atom: Quantum numbers and wavefunctions, atomic orbitals and their shapes (s, p, and d), Spin quantum number.
2.3 Many electron atoms: Pauli exclusion principle; Aufbau principle and the electronic configuration of atoms, Hund's rule.
2.4 Periodicity: Periodic law and the modern periodic table; Types of elements: s, p, d, and f blocks; Periodic trends: ionization energy, atomic and ionic radii, electron affinity, electro negativity and valency.
2.5 Nucleus: Natural and artificial radioactivity; Nuclear reactions.

**3. Chemical Bonding & Molecular Structure**

3.1 Ionic Bond: Lattice Energy and Born-Haber cycle
3.2 Molecular Structure: Lewis picture & resonance structures, VSEPR model & molecular shapes
3.3 Covalent Bond: Valence Bond Theory- Orbital overlap, Directionality of bonds & hybridistaion (s & p orbitals only), Resonance; Molecular orbital theory- Methodology, Orbital energy level diagram, Bond order, Magnetic properties for homonuclear diatomic species.
3.4 Metallic Bond: Qualitative description.
3.5 Intermolecular Forces: Polarity; Dipole moments; Hydrogen Bond.

**4. Thermodynamics**

4.1 Basic Concepts: Systems and surroundings; State functions; Intensive & Extensive Properties; Zeroth Law and Temperature
4.2 First Law of Thermodynamics: Work, internal energy, heat, enthalpy, heat capacities; Enthalpies of formation, phase transformation, ionization, electron gain; Thermochemistry; Hess's Law. Bond dissociation, combustion, atomization, sublimation, dilution
4.3 Second Law: Spontaneous and reversible processes; entropy; Gibbs free energy related to spontaneity and nonmechanical work; Standard free energies of formation, free energy change and chemical equilibrium; Third Law and Absolute Entropies.

**5. Physical and Chemical Equilibria**

5.1 Concentration Units: Mole Fraction, Molarity, and Molality
5.2 Solutions: Solubility of solids and gases in liquids, Vapour Pressure, Raoult's law, Relative lowering of vapour pressure, depression in freezing point; elevation in boiling point; osmotic pressure, determination of molecular mass.
5.3 Physical Equilibrium: Equilibria involving physical changes (solid-liquid, liquid-gas, solid-gas), Adsorption, Physical and Chemical adsorption, Langmuir Isotherm.
5.4 Chemical Equilibria: Equilibrium constants (KP, KC), Le-Chatelier's principle.
5.5 Ionic Equilibria: Strong and Weak electrolytes, Acids and Bases (Arrhenius, Lewis, Lowry and Bronsted) and their

dissociation; Ionization of Water; pH; Buffer solutions; Acid-base titrations; Hydrolysis; Solubility Product of
Sparingly Soluble Salts; Common Ion Effect.
5.6 Factors Affecting Equilibria: Concentration, Temperature, Pressure, Catalysts, Significance of ÄG and ÄG0 in
Chemical Equilibria.

**6. Electrochemistry**
6.1 Redox Reactions: Oxidation-reduction reactions (electron transfer concept); Oxidation number; Balancing of redox
reactions; Electrochemical cells and cell reactions; Electrode potentials; Idea of heterogeneous equilibria on the
surface of the electrode; EMF of Galvanic cells; Nernst equation; Factors affecting the electrode potential; Gibbs
energy change and cell potential; Concentration cells; Secondary cells; Fuel cells; Corrosion and its prevention.
6.2 Electrolytic Conduction: Electrolytic Conductance; Specific, equivalent and molar conductivities; Kolhrausch's
Law and its application, Faraday's laws of electrolysis; Coulometer; Electrode potential and electrolysis,
Commercial production of the chemicals, $NaOH$, $Na$, $Al_2$,$Cl_2$ , & $F_2$

**7. Chemical Kinetics**
7.1 Aspects of Kinetics: Rate and Rate expression of a reaction; Rate constant; Order and molecularity of the reaction;
Integrated rate expressions and half life for zero and first order reactions; Determination of rate constant and order
of reaction
7.2 Factor Affecting the Rate of the Reactions: Concentration of the reactants, size of particles; Temperature
dependence of rate constant; Activation energy; Catalysis, Surface catalysis, enzymes, zeolites; Factors affecting
rate of collisions between molecules; Effect of light.
7.3 Mechanism of Reaction: Elementary reactions; Complex reactions; Reactions involving two/three steps only;
Photochemical reactions; Concept of fast reactions.
7.4 Radioactive isotopes: Half-life period; Radiochemical dating.

**8. Hydrogen and s-block elements**
8.1 Hydrogen: Element: unique position in periodic table, occurrence, isotopes;

Dihydrogen: preparation, properties,
reactions, and uses; Molecular, saline, interstitial hydrides; Water: Properties; Structure and aggregation of water
molecules; Heavy water; Hydrogen peroxide; Hydrogen as a fuel.
8.2 s-block elements: Abundance and occurrence; Anomalous properties of the first elements in each group; diagonal
relationships.
8.3 Alkali metals: Lithium, sodium and potassium: occurrence, extraction, reactivity, and electrode potentials;
Biological importance; Reactions with oxygen, hydrogen, halogens and liquid ammonia; Basic nature of oxides
and hydroxides; Halides; Properties and uses of compounds such as NaCl, Na2CO3, NaHCO3, NaOH, KCl, and
KOH.
8.4 Alkaline earth metals: Magnesium and calcium: Occurrence, extraction, reactivity and electrode potentials;
Reactions with non-metals; Solubility and thermal stability of oxo salts; Biological importance; Properties and uses
of important compounds such as CaO, Ca(OH)2, plaster of Paris, MgSO4, MgCl2, CaCO3, and CaSO4; Lime and
limestone, cement.

**9. p- d- and f-block elements**

9.1 General: Abundance, distribution, physical and chemical properties, isolation and uses of elements; Trends in
chemical reactivity of elements of a group;.
9.2 Group 13 elements: Boron; Properties and uses of borax, boric acid, boron hydrides & halides. Reaction of
aluminum with acids and alkalis;
9.3 Group 14 elements: Carbon: Uses, Allotropes (graphite, diamond, fullerenes), oxides, halides and sulphides,
carbides; Silicon: Silica, silicates, silicone,.Zeolites.
9.4 Group 15 elements: Dinitrogen; Reactivity and uses of nitrogen and its compounds; Industrial and biological
nitrogen fixation; Ammonia: Haber's process, properties and reactions; Oxides of nitrogen and their structures;
Ostwald's process of nitric acid production; Fertilizers – NPK type; Production of phosphorus; Allotropes of
phosphorus; Preparation, structure and properties of hydrides, oxides, oxoacids and halides of phosphorus.

9.5 Group 16 elements: Isolation and chemical reactivity of dioxygen; Acidic, basic and amphoteric oxides;
Preparation, structure and properties of ozone; Allotropes of sulphur; Production of sulphur and sulphuric acid;
Structure and properties of oxides, oxoacids, hydrides and halides of sulphur.
9.6 Group 17 and group 18 elements: Structure and properties of hydrides, oxides, oxoacids of chlorine; Inter halogen
compounds; Bleaching Powder; Preparation, structure and reactions of xenon fluorides, oxides, and oxoacids.
9.7 d-block elements: General trends in the chemistry of first row transition elements; Metallic character; Oxidation
state; Ionic radii; Catalytic properties; Magnetic properties; Interstitial compounds; Occurrence and extraction of
iron, copper, silver, zinc, and mercury; Alloy formation; Steel and some important alloys; preparation and
properties of $CuSO_4$, $K_2Cr_2O_7$, $KMnO_4$, Mercury halides; Silver nitrate and silver halides; Photography.
9.8 f-block elements: Lanthanides and actinides; Oxidation states and chemical reactivity of lanthanide compounds;
Lanthanide contraction; Comparison of actinides and lanthanides.
9.9 Coordination Compounds: Coordination number; Ligands; Werner's coordination theory; IUPAC nomenclature;
Application and importance of coordination compounds (in qualitative analysis, extraction of metals and biological
systems e.g. chlorophyll, vitamin B12, and hemoglobin); Bonding: Valence-bond approach, Crystal field theory
(qualitative); Stability constants; Shapes, color and magnetic properties; Isomerism including stereoisomerisms;
Organometallic compounds.

**10. Principles of Organic Chemistry and Hydrocarbons**
10.1 Classification: Based on functional groups, trivial and IUPAC nomenclature.
10.2 Electronic displacement in a covalent bond: Inductive, resonance effects, and hyperconjugation; free radicals;
carbocations, carbanion, nucleophile and electrophile; types of reactions.
10.3 Alkanes and cycloalkanes: Structural isomerism and general properties.
10.4 Alkenes and alkynes: General methods of preparation and reactions, physical properties, electrophilic and free
radical additions, acidic character of alkynes and (1,2 and 1,4) addition to dienes.
10.5 Aromatic hydrocarbons: Sources; Properties; Isomerism; Resonance

delocalization; polynuclear hydrocarbons;
mechanism of electrophilic substitution reaction, directive influence and effect of substituents on reactivity.
10.6 Haloalkanes and haloarenes: Physical properties, chemical reactions.
10.7 Petroleum: Composition and refining, uses of petrochemicals.

**11. Stereochemistry**
11.1 Introduction: Chiral molecules; Optical activity; Polarimetry; R,S and D,L configurations; Fischer projections;
Enantiomerism; Racemates; Diastereomerism and meso structures.
11.2 Conformations: Ethane, propane, n-butane and cyclohexane conformations; Newman and sawhorse projections.
11.3 Geometrical isomerism in alkenes

**12. Organic Compounds with Functional Groups Containing Oxygen and Nitrogen**
12.1 General: Electronic structure, important methods of preparation, important reactions and physical properties of
alcohols, phenols, ethers, aldehydes, ketones, carboxylic acids, nitro compounds, amines, diazonium salts, cyanides
and isocyanides.
12.2 Specific: Effect of substituents on alpha-carbon on acid strength, comparative reactivity of acid derivatives, basic
character of amines and their separation, importance of diazonium salts in synthetic organic chemistry

**13. Biological , Industrial and Environmental chemistry**
**13.1 The Cell: Concept of cell and energy cycle.**
13.2 Carbohydrates: Classification; Monosaccharides; Structures of pentoses and hexoses; Anomeric carbon;
Mutarotation; Simple chemical reactions of glucose, Disaccharides: reducing and non-reducing sugars – sucrose,
maltose and lactose; Polysaccharides: elementary idea of structures of starch and cellulose.
13.3 Proteins: Amino acids; Peptide bond; Polypeptides; Primary structure of proteins; Simple idea of secondary ,
tertiary and quarternary structures of proteins; Denaturation of proteins and enzymes.
13.4 Nucleic Acids: Types of nucleic acids; Primary building blocks of nucleic acids (chemical composition of DNA &

RNA); Primary structure of DNA and its double helix; Replication; Transcription and protein synthesis; Genetic code.

13.5 Lipids, Hormones, Vitamins: Classification, structure, functions in biosystems.

13.6 Polymers: Classification of polymers; General methods of polymerization; Molecular mass of polymers; Biopolymers and biodegradable polymers; Free radical, cationic and anionic addition polymerizations; Copolymerization: Natural rubber; Vulcanization of rubber; Synthetic rubbers. Condensation polymers.

13.7 Pollution: Environmental pollutants; soil, water and air pollution; Chemical reactions in atmosphere; Smog; Major atmospheric pollutants; Acid rain; Ozone and its reactions; Depletion of ozone layer and its effects; Industrial air pollution; Green house effect and global warming; Green Chemistry.

13.8 Chemicals in medicine, health-care and food: Analgesics, Tranquilizers, antiseptics, disinfectants, anti-microbials, anti-fertility drugs, antihistamines, antibiotics, antacids; Cosmetics: Creams, perfumes, talcum powder, deodorants; Preservatives, artificial sweetening agents, antioxidants, and edible colours.

13.9 Other Industrial Chemicals: Dyes: Classification with examples – Indigo, methyl orange, aniline yellow, alizarin, malachite green; Advanced materials: Carbon fibers, ceramics, micro alloys; Detergents; Insect repellents, pheromones, sex attractants; Rocket Propellants.

**14. Theoretical Principles of Experimental Chemistry**

14.1 Volumetric Analysis: Principles; Standard solutions of sodium carbonate and oxalic acid; Acid-base titrations; Redox reactions involving KI, $H_2SO_4$, $Na_2SO_3$, $Na_2S_2O_3$and $H_2S$; Potassium permanganate in acidic, basic and neutral media; Titrations of oxalic acid, ferrous ammonium sulphate with $KMnO_4$, $K_2Cr_2O_7/Na_2S_2O_3$, $Cu(II)/Na_2S_2O_3$

14.2 Qualitative analysis of Inorganic Salts: Principles in the determination of the cations $Pb^{2+}$, $Cu^{2+}$, $As^{3+}$, $Mn^{2+}$, $Zn^{2+}$, $Co^{2+}$, $Ca^{2+}$, $Sr^{2+}$, $Ba^{2+}$, $Mg^{2+}$, $NH_4^+$, $Fe^{3+}$, $Ni^{2+}$ and the anions $CO_3^{2-}$, $S^{2-}$, $SO_4^{2-}$, $SO_3^{2-}$, $NO_2^-$, $NO_3^-$, $Cl^-$, $Br^-$, $I^-$, $PO_4^{3-}$,$CH_3COO^-$, $C_2O_4^{2-}$.

14.3 Physical Chemistry Experiments: crystallization of alum, copper sulphate, ferrous sulphate, double salt of alum and

ferrous sulphate, potassium ferric sulphate; Temperature vs. solubility; pH measurements; Lyophilic and lyophobic
sols; Dialysis; Role of emulsifying agents in emulsification. Equilibrium studies involving (i) ferric and
thiocyanate ions (ii) $[Co(H_2O)_6]^{2+}$ and chloride ions; Enthalpy determination for (i) strong acid vs. strong base
neutralization reaction (ii) hydrogen bonding interaction between acetone and chloroform; Rates of the reaction
between (i) sodium thiosulphate and hydrochloric acid, (ii) potassium iodate and sodium sulphite (iii) iodide vs.
hydrogen peroxide, concentration and temperature effects in these reactions;
14.4 Purification Methods: Filtration, crystallization, sublimation, distillation, differential extraction, and
chromatography. Principles of melting point and boiling point determination; principles of paper chromatographic
separation – Rf values.
14.5 Qualitative Analysis of Organic Compounds: Detection of nitrogen, sulphur, phosphorous and halogens; Detection
of carbohydrates, fats and proteins in foodstuff; Detection of alcoholic, phenolic, aldehydic, ketonic, carboxylic,
amino groups and unsaturation.
14.6 Quantitative Analysis of Organic Compounds: Basic principles for the quantitative estimation of carbon, hydrogen,
nitrogen, halogen, sulphur and phosphorous; Molecular mass determination by silver salt and chloroplatinate salt
methods; Elementary idea of mass spectrometer for accurate molecular mass determination; Calculations of
empirical and molecular formulae.
14.7 Principles of Organic Chemistry Experiments: Preparation of iodoform, acetanilide, p-nitro acetanilide, di-benzyl
acetone, aniline yellow, beta-naphthol; Preparation of acetylene and study of its acidic character.