SYLLABUS for JEE (Main)-2022

Syllabus for Paper-1 (B.E./B.Tech.)- Mathematics, Physics, and Chemistry

MATHEMATICS

UNIT 1: SETS, RELATIONS, AND FUNCTIONS:

Sets and their representation: Union, intersection and complement of sets and their algebraic properties; Power set; Relation, Type of relations, equivalence relations, functions; one-one, into and onto functions, the composition of functions.

UNIT 2: COMPLEX NUMBERS AND QUADRATIC EQUATIONS:

Complex numbers as ordered pairs of reals, Representation of complex numbers in the form a + ib and their representation in a plane, Argand diagram, algebra of complex number, modulus and argument (or amplitude) of a complex number, square root of a complex number, triangle inequality, Quadratic equations in real and complex number system and their solutions Relations between roots and co-efficient, nature of roots, the formation of quadratic equations with given roots.

UNIT3: MATRICES AND DETERMINANTS:

Matrices, algebra of matrices, type of matrices, determinants, and matrices of order two and three, properties of determinants, evaluation of determinants, area of triangles using determinants, Adjoint, and evaluation of inverse of a square matrix using determinants and elementary transformations, Test of consistency and solution of simultaneous linear equations in two or three variables using determinants and matrices.

UNIT 4: PERMUTATIONS AND COMBINATIONS:

The fundamental principle of counting, permutation as an arrangement and combination as section, Meaning of P (n,r) and C (n,r), simple applications.

UNIT 5: MATHEMATICAL INDUCTIONS:

Principle of Mathematical Induction and its simple applications.

UNIT 6: BINOMIAL THEOREM AND ITS SIMPLE APPLICATIONS:

Binomial theorem for a positive integral index, general term and middle term, properties of Binomial coefficients, and simple applications.

UNIT 7: SEQUENCE AND SERIES:

Arithmetic and Geometric progressions, insertion of arithmetic, geometric means between two given numbers, Relation between A.M and G.M sum up to n terms of special series; Sn, Sn2, Sn3. Arithmetico-Geometric progression.

UNIT 8: LIMIT, CONTINUITY, AND DIFFERENTIABILITY:

Real–valued functions, algebra of functions, polynomials, rational, trigonometric, logarithmic, and exponential functions, inverse function. Graphs of simple functions. Limits, continuity, and differentiability. Differentiation of the sum, difference, product, and quotient of two functions. Differentiation of trigonometric, inverse trigonometric, logarithmic, exponential, composite and implicit functions; derivatives of order up to two, Rolle's and Lagrange's Mean value Theorems, Applications of derivatives: Rate of change of quantities, monotonic-Increasing and decreasing functions, Maxima and minima of functions of one variable, tangents and normal.

UNIT 9: INTEGRAL CALCULAS:

Integral as an anti-derivative, Fundamental Integrals involving algebraic, trigonometric, exponential, and logarithms functions. Integrations by substitution, by parts, and by partial functions. Integration using trigonometric identities.

Evaluation of simple integrals of the type

$\int \frac{dx}{x^2+a^2}$, $\int \frac{dx}{\sqrt{x^2 \pm a^2}}$, $\int \frac{dx}{a^2-x^2}$, $\int \frac{dx}{\sqrt{a^2-x^2}}$, $\int \frac{dx}{ax^2+bx+c}$, $\int \frac{dx}{\sqrt{ax^2+bx+c}}$, $\int \frac{(px+q)dx}{ax^2+bx+c}$,

$\int \frac{(px+q)dx}{\sqrt{ax^2+bx+c}}$ $\int \sqrt{a^2 \pm x^2}\, dx$, $\int \sqrt{x^2 - a^2}\, dx$

Integral as limit of a sum. The fundamental theorem of calculus, properties of definite integrals. Evaluation of definite integrals, determining areas of the regions bounded by simple curves in standard form.

UNIT 10: DIFFRENTIAL EQUATIONS

Ordinary differential equations, their order, and degree, the formation of differential equations, solution of differential equation by the method of separation of variables, solution of a homogeneous and linear differential equation of the type

$\frac{dy}{dx} + p(x)y = q(x)$

UNIT 11: CO-ORDINATE GEOMETRY

Cartesian system of rectangular coordinates in a plane, distance formula, sections formula, locus, and its equation, translation of axes, the slope of a line, parallel and perpendicular lines, intercepts of a line on the co-ordinate axis.

Straight line

Various forms of equations of a line, intersection of lines, angles between two lines, conditions for concurrence of three lines, the distance of a point form a line, equations of internal and external by sectors of angles between two lines co-ordinate of the centroid, orthocentre, and circumcentre of a triangle, equation of the family of lines passing through the point of intersection of two lines.

Circle, conic sections

A standard form of equations of a circle, the general form of the equation of a circle, its radius and central, equation of a circle when the endpoints of a diameter are given, points of intersection of a line and a circle with the centre at the origin and condition for a line to be tangent to a circle, equation of the tangent, sections of conics, equations of conic sections (parabola, ellipse, and hyperbola) in standard forms, condition for Y = mx +c to be a tangent and point (s) of tangency.

UNIT 12: THREE DIMENSIONAL GEOMETRY

Coordinates of a point in space, the distance between two points, section formula, directions ratios, and direction cosines, the angle between two intersecting lines. Skew lines, the shortest distance between them, and its equation. Equations of a line and a plane in different forms, the intersection of a line and a plane, coplanar lines.

UNIT 13: VECTOR ALGEBRA

Vectors and scalars, the addition of vectors, components of a vector in two dimensions and three-dimensional space, scalar and vector products, scalar and vector triple product.

UNIT 14: STATISTICS AND PROBABILITY

Measures of discretion; calculation of mean, median, mode of grouped and ungrouped data calculation of standard

deviation, variance and mean deviation for grouped and ungrouped data.

Probability: Probability of an event, addition and multiplication theorems of probability, Baye's theorem, probability distribution of a random variate, Bernoulli trials, and binomial distribution.

UNIT 15: TRIGONOMETRY

Trigonometrical identities and equations, trigonometrical functions, inverse trigonometrical functions, and their properties, heights, and distance.

UNIT 16: MATHEMATICAL REASONING

Statement logical operations and, or, implies, implied by, if and only if, understanding of tautology, contradiction, converse, and contrapositive.

PHYSICS

UNIT 1: PHYSICS AND MEASUREMENT

Physics, technology, and society, S I Units, fundamental and derived units, least count, accuracy and precision of measuring instruments, Errors in measurement, Dimensions of Physics quantities, dimensional analysis, and its applications.

UNIT 2: KINEMATICS

The frame of reference, motion in a straight line, Position- time graph, speed and velocity; Uniform and non-uniform motion, average speed and instantaneous velocity, uniformly accelerated motion, velocity-time, position-time graph, relations for uniformly accelerated motion, Scalars and Vectors, Vector. Addition and subtraction, zero vector, scalar and vector products, Unit Vector, Resolution of a Vector. Relative Velocity, Motion in a plane, Projectile Motion, Uniform Circular Motion.

UNIT 3: LAWS OF MOTION

Force and inertia, Newton's First law of motion; Momentum, Newton's Second Law of motion, Impulses; Newton's Third Law of motion. Law of conservation of linear momentum and its applications. Equilibrium of concurrent forces.

Static and Kinetic friction, laws of friction, rolling friction.

Dynamics of uniform circular motion: centripetal force and its applications.

UNIT 4: WORK, ENERGY, AND POWER

Work done by a content force and a variable force; kinetic and potential energies, work-energy theorem, power.

The potential energy of spring conservation of mechanical energy, conservative and neoconservative forces; Elastic and inelastic collisions in one and two dimensions.

UNIT5: ROTATIONAL MOTION

Centre of the mass of a two-particle system, Centre of the mass of a rigid body; Basic concepts of rotational motion; a moment of a force; torque, angular momentum, conservation of angular momentum and its applications; the moment of inertia, the radius of gyration. Values of moments of inertia for

simple geometrical objects, parallel and perpendicular axes theorems, and their applications. Rigid body rotation equations of rotational motion.

UNIT 6: GRAVITATION

The universal law of gravitation. Acceleration due to gravity and its variation with altitude and depth. Kepler's law of planetary motion. Gravitational potential energy; gravitational potential. Escape velocity, Orbital velocity of a satellite. Geo stationary satellites.

UNIT 7: PROPERTIES OF SOLIDS AND LIQUIDS

Elastic behaviour, Stress-strain relationship, Hooke's Law. Young's modulus, bulk modulus, modulus of rigidity. Pressure due to a fluid column; Pascal's law and its applications. Viscosity. Stokes' law. terminal velocity, streamline, and turbulent flow. Reynolds number. Bernoulli's principle and its applications. Surface energy and surface tension, angle of contact, application of surface tension - drops, bubbles, and capillary rise. Heat, temperature, thermal expansion; specific heat capacity, calorimetry; change of state, latent heat. Heat transfer-conduction, convection, and radiation. Newton's law of cooling.

UNIT 8: THERMODYNAMICS

Thermal equilibrium, zeroth law of thermodynamics, the concept of temperature. Heat, work, and internal energy. The first law of thermodynamics. The second law of thermodynamics: reversible and irreversible processes. Carnot engine and its efficiency.

UNIT 9: KINETIC THEORY OF GASES

Equation of state of a perfect gas, work done on compressing a gas, Kinetic theory of gases - assumptions, the concept of pressure. Kinetic energy and temperature: RMS speed of gas molecules: Degrees of freedom. Law of equipartition of energy, applications to specific heat capacities of gases; Mean free path. Avogadro's number.

UNIT 10: OSCILLATIONS AND WAVES

Periodic motion - period, frequency, displacement as a function of time. Periodic functions. Simple harmonic motion (S.H.M.) and its equation; phase: oscillations of a spring -restoring force and force constant: energy in S.H.M. - Kinetic and potential energies; Simple pendulum - derivation of expression for its time period: Free, forced and damped oscillations, resonance.

Wave motion. Longitudinal and transverse waves, speed of a wave. Displacement relation for a progressive wave. Principle of superposition of waves, a reflection of waves. Standing waves in strings and organ pipes, fundamental mode and harmonics. Beats. Doppler Effect in sound

UNIT 11: ELECTROSTATICS

Electric charges: Conservation of charge. Coulomb's law forces between two point charges, forces between multiple charges: superposition principle and continuous charge distribution.

Electric field: Electric field due to a point charge, Electric field lines. Electric dipole, Electric field due to a dipole. Torque on a dipole in a uniform electric field.

Electric flux. Gauss's law and its applications to find field due to infinitely long uniformly charged straight wire, uniformly charged infinite plane sheet, and uniformly charged thin spherical shell. Electric potential and its calculation for a point charge, electric dipole and system of charges; Equipotential surfaces, Electrical potential energy of a system of two point charges in an electrostatic field.

Conductors and insulators. Dielectrics and electric polarization, capacitor, the combination of capacitors in series and parallel, capacitance of a parallel plate capacitor with and without dielectric medium between the plates. Energy stored in a capacitor.

UNIT 12: CURRENT ELECTRICITY

Electric current. Drift velocity. Ohm's law. Electrical resistance. Resistances of different materials. V-l characteristics of Ohmic and non-ohmic conductors. Electrical energy and power. Electrical resistivity. Colour code for resistors; Series and parallel combinations of resistors; Temperature dependence of resistance.

Electric Cell and its Internal resistance, potential difference and emf of a cell, a combination of cells in series and parallel. Kirchhoff's laws and their applications. Wheatstone bridge. Metre Bridge. Potentiometer - principle and its applications.

UNIT 13: MAGNETIC EFFECTS OF CURRENT AND MAGNETISM

Biot - Savart law and its application to current carrying circular loop. Ampere's law and its applications to infinitely long current carrying straight wire and solenoid. Force on a moving charge in uniform magnetic and electric fields. Cyclotron.

Force on a current-carrying conductor in a uniform magnetic field. The force between two parallel currents carrying conductors-definition of ampere. Torque experienced by a current loop in a uniform magnetic field: Moving coil galvanometer, its current sensitivity, and conversion to ammeter and voltmeter.

Current loop as a magnetic dipole and its magnetic dipole moment. Bar magnet as an equivalent solenoid, magnetic field lines; Earth's magnetic field and magnetic elements. Para-, dia- and ferromagnetic substances. Magnetic susceptibility and permeability. Hysteresis. Electromagnets and permanent magnets.

UNIT 14: ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENTS

Electromagnetic induction: Faraday's law. Induced emf and current: Lenz's Law, Eddy currents. Self and mutual inductance. Alternating currents, peak

and RMS value of alternating current/ voltage: reactance and impedance: LCR series circuit, resonance: Quality factor, power in AC circuits, wattless current. AC generator and transformer.

UNIT 15: ELECTROMAGNETIC WAVES

Electromagnetic waves and their characteristics, Transverse nature of electromagnetic waves, Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet. X-rays. Gamma rays), Applications of e.m. waves.

UNIT 16: OPTICS

Reflection and refraction of light at plane and spherical surfaces, mirror formula. Total internal reflection and its applications. Deviation and Dispersion of light by a; prism; Lens Formula. Magnification. Power of a Lens. Combination of thin lenses in contact. Microscope and Astronomical Telescope (reflecting and refracting) and their magnifying powers.

Wave optics: wavefront and Huygens' principle. Laws of reflection and refraction using Huygens principle. Interference, Young's double-slit experiment and expression for fringe width, coherent sources, and sustained interference of light. Diffraction due to a single slit, width of central maximum. Resolving power of microscopes and astronomical telescopes. Polarization, plane-polarized light: Brewster's law, uses of plane-polarized light and Polaroid.

UNIT 17: DUAL NATURE OF MATTER AND RADIATION

Dual nature of radiation. Photoelectric effect. Hertz and Lenard's observations; Einstein's photoelectric equation: particle nature of light. Matter waves-wave nature of particle, de Broglie relation. Davisson-Germer experiment.

UNIT 18: ATOMS AND NUCLEI

Alpha-particle scattering experiment; Rutherford's model of atom; Bohr model, energy levels, hydrogen spectrum. Composition and size of nucleus, atomic masses, isotopes, isobars: isotones. Radioactivity-alpha. beta and gamma particles/rays and their properties; radioactive decay law. Mass-energy relation, mass defect; binding energy per nucleon and its variation with mass number, nuclear fission, and fusion.

UNIT 19: ELECTRONIC DEVICES

Semiconductors; semiconductor diode: 1-V characteristics in forward and reverse bias; diode as a rectifier; I-V characteristics of LED. the photodiode, solar cell, and Zener diode; Zener diode as a voltage regulator. Junction transistor, transistor action, characteristics of a transistor: transistor as an amplifier (common emitter configuration) and oscillator. Logic gates (OR. AND. NOT. NAND and NOR). Transistor as a switch.

UNIT 20: COMMUNICATION SYSTEMS

Propagation of electromagnetic waves in the atmosphere; Sky and space wave propagation. Need for modulation. Amplitude and Frequency Modulation, Bandwidth of signals. the bandwidth of Transmission medium, Basic Elements of a Communication System (Block Diagram only).

UNIT 21: EXPERIMENTAL SKILLS

Familiarity with the basic approach and observations of the experiments and activities:

1. Vernier calipers-its use to measure the internal and external diameter and depth of a vessel.
2. Screw gauge-its use to determine thickness/ diameter of thin sheet/wire.
3. Simple Pendulum-dissipation of energy by plotting a graph between the square of amplitude and time.
4. Metre Scale - the mass of a given object by the principle of moments.
5. Young's modulus of elasticity of the material of a metallic wire.
6. Surf ace tension of water by capillary rise and effect of detergents,
7. Co-efficient of Viscosity of a given viscous liquid by measuring terminal velocity of a given spherical **body,**
8. Plotting a cooling curve for the relationship between the temperature of a hot body and time.
9. Speed of sound in air at room temperature using a resonance tube,
10. Specific heat capacity of a given (i) solid and (ii) liquid by method of mixtures.
11. The resistivity of the material of a given wire using a metre bridge.
12. The resistance of a given wire using Ohm's law.
13. Potentiometer-
    i. Comparison of emf of two primary cells.
    ii. Determination of internal resistance of a cell.
14. Resistance and figure of merit of a galvanometer by half deflection method.
15. The focal length of;
    (i) Convex mirror
    (ii) Concave mirror, and
    (ii) Convex lens,
    using the parallax
    method.
16. The plot of the angle of deviation vs angle of incidence for a triangular prism.
17. Refractive index of a glass slab using a

travelling microscope.

18. Characteristic curves of a p-n junction diode in forward and reverse bias.
19. Characteristic curves of a Zener diode and finding reverse break down voltage.
20. Characteristic curves of a transistor and finding current gain and voltage gain.
21. Identification of Diode. LED, Transistor. IC. Resistor. A capacitor from a mixed collection of such items.
22. Using a multimeter to:

    (i) Identify the base of a transistor

    (ii) Distinguish between NPN and PNP type transistor

    (iii) See the unidirectional current in case of a diode and an LED.

    (iv) Check the correctness or otherwise of a given electronic component (diode, transistor, or IC).

CHEMISTRY

PHYSICAL CHEMISTRY

UNIT I: SOME BASIC CONCEPTS IN CHEMISTRY

Matter and its nature, Dalton's atomic theory: Concept of atom, molecule, element, and compound: Physical quantities and their measurements in Chemistry, precision, and accuracy, significant figures. S.I.Units, dimensional analysis: Laws of chemical combination; Atomic and molecular masses, mole concept, molar mass, percentage composition, empirical and molecular formulae: Chemical equations and stoichiometry.

UNIT 2: STATES OF MATTER

Classification of matter into solid, liquid, and gaseous states.

Gaseous State:

Measurable properties of gases: Gas laws - Boyle's law, Charle's law. Graham's law of diffusion. Avogadro's law, Dalton's law of partial pressure; Concept of Absolute scale of temperature; Ideal gas equation; Kinetic theory of gases (only postulates); Concept of average, root mean square and most probable velocities; Real gases, deviation from Ideal behaviour, compressibility factor, and van der Waals equation.

Liquid State:

Properties of liquids - vapour pressure, viscosity and surface tension, and effect of temperature on them (qualitative treatment only).

Solid State:

Classification of solids: molecular, ionic, covalent and metallic solids, amorphous and crystalline solids (elementary idea); Bragg's Law and its applications: Unit cell and lattices, packing in solids (fcc, bcc and hcp lattices), voids, calculations involving unit cell parameters, an imperfection in solids; Electrical and magnetic properties.

UNIT 3: ATOMIC STRUCTURE

Thomson and Rutherford atomic models and their limitations; Nature of electromagnetic radiation, photoelectric effect; Spectrum of the hydrogen atom. Bohr model of a hydrogen atom - its postulates, derivation of the relations for the energy of the electron and radii of the different orbits, limitations of Bohr's model; Dual nature of matter, de Broglie's relationship. Heisenberg uncertainty principle. Elementary ideas of quantum mechanics, quantum mechanics, the quantum mechanical model of the atom, its important 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 for filling electrons in orbitals – Aufbau principle. Pauli's exclusion principle and Hund's rule, electronic configuration of elements, extra stability of half-filled and completely filled orbitals.

UNIT 4: CHEMICAL BONDING AND MOLECULAR STRUCTURE

Kossel - Lewis approach to chemical bond formation, the concept of ionic and covalent bonds.

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.

Elementary idea of metallic bonding. Hydrogen bonding and its applications.

UNIT 5: CHEMICAL THERMODYNAMICS

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

The first law of thermodynamics - Concept of work, heat internal energy and enthalpy, heat capacity, molar heat capacity; Hess's law of constant heat summation; Enthalpies of bond 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 of the system as criteria for spontaneity. ΔG° (Standard Gibbs energy change) and equilibrium constant.

UNIT 6: SOLUTIONS

Different methods for expressing the concentration of solution - molality, molarity, mole fraction, percentage (by volume and mass both), the vapour pressure of solutions and Raoult'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; Determination of molecular mass using colligative properties; Abnormal value of molar mass, van't Hoff factor and its significance.

UNIT 7: EQUILIBRIUM

Meaning of equilibrium, the concept of dynamic equilibrium.

Equilibria involving physical processes: Solid-liquid, liquid - 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, buffer solutions.

UNIT 8: REDOX REACTIONS AND ELECTROCHEMISTRY

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

Electrochemical cells - Electrolytic and Galvanic cells, different types of electrodes, electrode potentials including standard electrode potential, half - cell and cell reactions, emf of a Galvanic cell and its measurement: Nernst equation and its applications; Relationship between cell potential and Gibbs' energy change: Dry cell and lead accumulator; Fuel cells.

UNIT 9: CHEMICAL KINETICS

Rate of a chemical reaction, factors affecting the rate of reactions: concentration, temperature, pressure, and catalyst; elementary and complex reactions, order and molecularity of reactions, rate law, rate constant and its units, differential and integral forms of zero and first-order reactions, their characteristics and half-lives, the effect of temperature on the rate of reactions, Arrhenius theory, activation energy and its calculation, collision theory of bimolecular gaseous reactions (no derivation).

UNIT 10: SURFACE CHEMISTRY

Adsorption- Physisorption and chemisorption and their characteristics, factors affecting adsorption of gases on solids - Freundlich and Langmuir adsorption isotherms, adsorption from solutions.

Catalysis - Homogeneous and heterogeneous, activity and selectivity of solid catalysts, enzyme catalysis, and its mechanism.

Colloidal state- distinction among true solutions, colloids, and suspensions, classification of colloids - lyophilic. lyophobic; multi-molecular. macromolecular and associated colloids (micelles), preparation and properties of colloids - Tyndall effect. Brownian movement, electrophoresis, dialysis, coagulation, and flocculation: Emulsions and their characteristics.

INORGANIC CHEMISTRY

UNIT 11: CLASSIFICATION OF ELEMENTS AND PERIODICITY IN 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.

UNIT 12: GENERAL PRINCIPLES AND PROCESSES OF ISOLATION OF METALS

Modes of occurrence of elements in nature, minerals, ores; Steps involved in the extraction of metals - concentration, reduction (chemical and electrolytic methods), and refining with special reference to the extraction of Al. Cu, Zn, and Fe; Thermodynamic and electrochemical principles involved in the extraction of **metals.**

UNIT 13: HYDROGEN

Position of hydrogen in periodic table, isotopes, preparation, properties and uses of hydrogen; Physical and chemical properties of water and heavy water; Structure, preparation, reactions, and uses of hydrogen peroxide; Classification of hydrides - ionic, covalent, and interstitial; Hydrogen as a fuel.

UNIT 14: S -BLOCK ELEMENTS (ALKALI AND ALKALINE EARTH METALS)

Group -1 and 2 Elements

General introduction, electronic configuration, and general trends in physical and chemical properties of elements, anomalous properties of the first element of each group, diagonal relationships.

Preparation and properties of some important compounds - sodium carbonate and sodium hydroxide and sodium hydrogen carbonate; Industrial uses of lime, limestone. Plaster of Paris and cement: Biological significance of Na, K. Mg, and Ca.

UNIT 15: P- BLOCK ELEMENTS

Group -13 to Group 18 Elements

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.

Groupwise study of the p - block elements Group -13

Preparation, properties, and uses of boron and aluminum; Structure, properties, and uses of borax, boric acid, diborane, boron trifluoride, aluminum chloride, and alums.

Group -14

The tendency for catenation; Structure, properties, and uses of Allotropes and oxides of carbon, silicon tetrachloride, silicates, zeolites, and silicones.

Group -15

Properties and uses of nitrogen and phosphorus; Allotrophic forms of phosphorus; Preparation, properties, structure, and uses of ammonia, nitric acid, phosphine, and phosphorus halides, (PCl_3. PCl_5); Structures of oxides and oxoacids of nitrogen and phosphorus.

Group -16

Preparation, properties, structures, and uses of ozone: Allotropic forms of sulphur; Preparation, properties, structures, and uses of sulphuric acid (including its industrial preparation); Structures of oxoacids of sulphur.

Group-17

Preparation, properties, and uses of hydrochloric acid; Trends in the acidic nature of hydrogen halides; Structures of Interhalogen compounds and oxides and oxoacids of halogens.

Group-18

Occurrence and uses of noble gases; Structures of fluorides and oxides of xenon.

UNIT 16: 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 $KMnO_4$.

Inner Transition Elements

Lanthanoids - Electronic configuration, oxidation states, and lanthanoid contraction.

Actinoids - Electronic configuration and oxidation states.

UNIT 17: CO-ORDINATION COMPOUNDS

Introduction to coordination compounds. Werner's theory; ligands, coordination number, denticity. chelation; IUPAC nomenclature of mononuclear co-ordination compounds, isomerism; Bonding-Valence bond approach and basic ideas of Crystal field theory, colour and magnetic properties; Importance of co-ordination compounds (in qualitative analysis, extraction of metals and in biological systems).

UNIT 18: ENVIRONMENTAL CHEMISTRY

Environmental pollution - Atmospheric, water, and soil.

Atmospheric pollution - Tropospheric and Stratospheric

Tropospheric pollutants - Gaseous pollutants: Oxides of carbon, nitrogen, and sulphur, hydrocarbons; their sources, harmful effects, and prevention; Greenhouse effect and Global warming: Acid rain;

Particulate pollutants: Smoke, dust, smog, fumes, mist; their sources, harmful effects, and prevention.

Stratospheric pollution- Formation and breakdown of ozone, depletion of the ozone layer - its mechanism and effects.

Water Pollution - Major pollutants such as. pathogens, organic wastes, and chemical pollutants; their harmful effects and prevention.

Soil pollution - Major pollutants such as; Pesticides (insecticides. herbicides and fungicides), their harmful effects, and prevention. Strategies to control environmental pollution.

ORGANIC CHEMISTRY

UNIT 19: PURIFICATION AND CHARACTERISATION OF ORGANIC COMPOUNDS

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

Qualitative analysis - Detection of nitrogen, sulphur, phosphorus, and halogens.

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

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

UNIT 20:SOME BASIC PRINCIPLES OF ORGANIC CHEMISTRY

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 (Trivial and IUPAC)

Covalent bond fission - Homolytic and heterolytic: free radicals, carbocations, and carbanions; stability of carbocations and free radicals, electrophiles, and nucleophiles.

Electronic displacement in a covalent bond

- Inductive effect, electromeric effect, resonance, and hyperconjugation.

Common types of organic reactions- Substitution, addition, elimination, and rearrangement.

UNITS 21: 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 - Geometrical isomerism: Mechanism of electrophilic addition: addition of hydrogen, halogens, water, hydrogen halides (Markownikoffs and peroxide effect): Ozonolysis and polymerization.

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

Aromatic hydrocarbons - Nomenclature, benzene - structure and aromaticity: Mechanism of electrophilic substitution: halogenation, nitration.

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

UNIT 22: ORGANIC COMPOUNDS CONTAINING HALOGENS

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

Uses; Environmental effects of chloroform, iodoform freons, and DDT.

UNIT 23: ORGANIC COMPOUNDS CONTAINING OXYGEN

General methods of preparation, properties, reactions, and uses.

ALCOHOLS, PHENOLS, AND ETHERS

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.

Carboxylic Acids

Acidic strength and factors affecting it,

UNIT 24: ORGANIC COMPOUNDS CONTAINING NITROGEN

General methods of preparation. Properties, reactions, and uses.

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

Diazonium Salts: Importance in synthetic organic chemistry.

UNIT 25: POLYMERS

General introduction and classification of polymers, **general** methods of polymerization, - Addition and condensation, copolymerization.

Natural and synthetic, rubber and vulcanization, some important polymers with emphasis on their monomers and uses – polythene, nylon, polyester, and bakelite.

UNIT 26: BIOMOLECULES

General introduction and importance of biomolecules.

CARBOHYDRATES - Classification; aldoses and ketoses: monosaccharides (glucose and fructose) and constituent monosaccharides of oligosaccharides (sucrose, lactose, and maltose).

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 – Classification and functions.

NUCLEIC ACIDS – Chemical constitution of DNA and RNA.

Biological functions of nucleic acids.

UNIT 27: CHEMISTRY IN EVERYDAY LIFE

Chemicals in Medicines - Analgesics, tranquilizers, antiseptics, disinfectants, antimicrobials, anti-fertility drugs, antibiotics, antacids. Anti-histamines -their meaning and common examples.

Chemicals in food - Preservatives, artificial sweetening agents - common examples.

Cleansing Agents - Soaps and detergents, cleansing action

UNIT 28: PRINCIPLES RELATED TO PRACTICAL CHEMISTRY

Detection of extra elements (Nitrogen, Sulphur, halogens) in organic compounds; Detection of the following functional groups; hydroxyl (alcoholic and phenolic), carbonyl (aldehyde and ketones) carboxyl, and amino groups in organic compounds.

- The chemistry involved in the preparation of the following:

  Inorganic compounds; Mohr's salt, potash alum.

  Organic compounds: Acetanilide, p-nitro acetanilide, aniline yellow, 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-}, $NO3^-$, NO^{2-}, Cl^-, Br^-, I^- (Insoluble salts excluded).

  Chemical principles involved in the following experiments:

  1. Enthalpy of solution of $CuSO_4$
  2. Enthalpy of neutralization of strong acid and strong base.
  3. Preparation of lyophilic and lyophobic sols.
  4. Kinetic study of the reaction of iodide ions with hydrogen peroxide at room temperature.

Syllabus for Paper 2A (B.Arch)

MATHEMATICS

UNIT 1: SETS, RELATIONS, AND FUNCTIONS:

Sets and their representation: Union, intersection and complement of sets and their algebraic properties; Power set; Relation, Type of relations, equivalence relations, functions; one-one, into and onto functions, the composition of functions.

UNIT 2: COMPLEX NUMBERS AND QUADRATIC EQUATIONS:

Complex numbers as ordered pairs of reals, Representation of complex numbers in the form a + ib and their representation in a plane, Argand diagram, algebra of complex number, modulus and argument (or amplitude) of a complex number, triangle inequality, Quadratic equations in real and complex number system and their solutions Relations between roots and co-efficient, nature of roots, the formation of quadratic equations with given roots.

UNIT 3: MATRICES AND DETERMINANTS:

Matrices, algebra of matrices, type of matrices, determinants, and matrices of order two and three, properties of determinants, evaluation of determinants, area of triangles using determinants, Adjoint, and evaluation of inverse of a square matrix using determinants and elementary transformations, Test of consistency and solution of simultaneous linear equations in two or three variables using determinants and matrices.

UNIT4:PERMUTATIONS AND COMBINATIONS:

The fundamental principle of counting, permutation as an arrangement and combination as section, Meaning of P (n,r) and C (n,r), simple applications.

UNIT 5: MATHEMATICAL INDUCTIONS:

Principle of Mathematical Induction and its simple applications.

UNIT 6: BINOMIAL THEOREM AND ITS SIMPLE APPLICATIONS:

Binomial theorem for a positive integral index, general term and middle term, properties of Binomial coefficients, and simple applications.

UNIT 7: SEQUENCE AND SERIES:

Arithmetic and Geometric progressions, insertion of arithmetic, geometric means between two given numbers, Relation between A.M and G.M sum up to n terms of special series; Sn, Sn2, Sn3. Arithmetico-Geometric progression.

UNIT 8: LIMIT, CONTINUITY, AND DIFFERENTIABILITY:

Real–valued functions, algebra of functions, polynomials, rational, trigonometric, logarithmic, and exponential functions, inverse function. Graphs of simple functions. Limits, continuity, and differentiability. Differentiation of the sum, difference, product, and quotient of two functions. Differentiation of trigonometric, inverse trigonometric, logarithmic, exponential, composite and implicit functions; derivatives of order up to two, Rolle's and Lagrange's Mean value Theorems, Applications of derivatives: Rate of change of quantities, monotonic-Increasing and decreasing functions, Maxima and minima of functions of one variable, tangents and normal.

UNIT 9: INTEGRAL CALCULAS:

Integral as an anti-derivative, Fundamental Integrals involving algebraic, trigonometric,

exponential, and logarithms functions. Integrations by substitution, by parts, and by partial functions. Integration using trigonometric identities.

Evaluation of simple integrals of the type

$\int \frac{dx}{x^2+a^2}$, $\int \frac{dx}{\sqrt{x^2 \pm a^2}}$, $\int \frac{dx}{a^2- x^2}$, $\int \frac{dx}{\sqrt{a^2- x^2}}$, $\int \frac{dx}{ax^2+bx+c}$, $\int \frac{dx}{\sqrt{ax^2+ bx+c}}$, $\int \frac{(px+q)dx}{ax^2+bx+c}$, $\int \frac{(px+q)dx}{\sqrt{ax^2+ bx+c}}$, $\int \sqrt{a^2 \pm x^2}\ dx$, $\int \sqrt{x^2 - a^2}\ dx$

Integral as limit of a sum. The fundamental theorem of calculus, properties of definite integrals. Evaluation of definite integrals, determining areas of the regions bounded by simple curves in standard form.

UNIT 10: DIFFRENTIAL EQUATIONS

Ordinary differential equations, their order, and degree, the formation of differential equations, solution of differential equation by the method of separation of variables, solution of a homogeneous and linear differential equation of the type

$\frac{dy}{dx} + p(x)y = q(x)$

UNIT11: CO-ORDINATE GEOMETRY

Cartesian system of rectangular coordinates 10 in a plane, distance formula, sections formula, locus, and its equation, translation of axis, slop of a line, parallel and perpendicular lines, intercept of a line on the co-ordinate axes.

Straight line

Various forms of equations of a line, intersection of lines, angles between two lines, conditions for concurrence of three lines, the distance of a point form a line, equations of internal and external by sectors of angles between two lines co-ordinate of the centroid, orthocentre, and circumcentre of a triangle, equation of the family of lines passing through the point of intersection of two lines.

Circle, conic sections

A standard form of equations of a circle, the general form of the equation of a circle, its radius and central, equation of a circle when the endpoints of a diameter are given, points of intersection of a line and a circle with the centre at the origin and condition for a line to be tangent to a circle, equation of the tangent, sections of conics, equations of conic sections (parabola, ellipse, and hyperbola) in standard forms, condition for Y = mx + c to be a tangent and point (s) of tangency.

UNIT12:THREE DIMENSIONAL GEOMETRY

Coordinates of a point in space, the distance between two points, section formula, directions ratios, direction cosines, the angle between two intersecting lines. Skew lines, the shortest distance between them, and its equation. Equations of a line and a plane in different forms, the intersection of a line and a plane, coplanar lines.

UNIT 13: VECTOR ALGEBRA

Vectors and scalars, the addition of vectors, components of a vector in two dimensions and three-dimensional space, scalar and vector products, scalar and vector triple product.

UNIT 14: STATISTICS AND PROBABILITY

Measures of discretion; calculation of mean, median, mode of grouped and ungrouped data calculation of standard deviation, variance and mean deviation for grouped and ungrouped data.

Probability: Probability of an event, addition and multiplication theorems of probability, Baye's theorem, probability distribution of a random variate, Bernoulli trials, and binomial distribution.

UNIT 15: TRIGONOMETRY

Trigonometrical identities and equations, trigonometrical functions, inverse trigonometrical functions, and their properties, heights, and distance.

UNIT 16: MATHEMATICAL REASONING

Statement logical operations and, or, implies, implied by, if and only if, understanding of tautology, contradiction, converse, and contrapositive.

Part –II APTITUDE

UNIT - 1 Awareness of persons. Buildings, Materials.

Objects, Texture related to Architecture and Build-envirounmentVisusalising three-dimensional objects from two-dimensional drawings. Visualizing. Different sides of three-dimensional objects. Analytical Reasoning Mental Ability (Visual. Numerical and Verbal)

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Part – III DRAWING

Sketching of scenes and activities from memory of urbanscape (public space, market, festivals, street scenes, monuments, recreational spaces, etc). landscape (riverfronts. Jungle. Gardens, trees. Plants, etc.) and rural life.

To be conducted in a Drawing sheet.

Note: Candidates are advised to bring pencils. Own geometry box set, crasets and colour pencils, and crayons for the Drawing Test.

Syllabus for Paper 2B (B.Planning)

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PLANNING

UNIT-1 GENERAL AWARENESS

General knowledge questions and knowledge about prominent cities, development issues, government programs, etc.

UNIT-2 SOCIAL SCIENCES

The idea of nationalism, nationalism in India, pre-modern world, 19th-century global economy, colonialism, and colonial cities, industrialization, resources, and development, types of resources, agriculture, water, mineral resources, industries, national economy; Human Settlements

Power-sharing, federalism, political parties, democracy, the constitution of India

Economic development- economic sectors, globalization, the concept of development, poverty; Population structure, social exclusion, and inequality, urbanization, rural development, colonial cities,

UNIT-3 THINKING SKILLS

Comprehension (unseen passage); map reading skills, scale, distance, direction, area, etc.; critical reasoning; understanding of charts, graphs, and tables; basic concepts of statistics and quantitative reasoning.