

## Plan of Written Examination

All the aspirants are informed as under with respect to the written test to be conducted for the recruitment of **Forester** :-

- (i) The Exam will be conducted in MCQ (Multiple Choice Questions) format. OMR sheets will be used for answering the questions.
- (ii) There will be negative marking. Each question carries 1 mark. **For every wrong answer, 1/4<sup>th</sup> mark would be deducted. The question(s) not attempted will receive no credit or discredit.**
- (iii) The test would be of 2 hours duration.
- iv) Pattern of the written competitive examination is as follows:-

Sr. No.	Topic	No. of Questions	Marks (Each Question carries 1 mark)	Type of Questions
1.	Questions from the Syllabus (Part A of syllabus)	90	90	MCQs (Multiple Choice Questions)
2.	Questions from General Knowledge, English, Punjabi, Logical Reasoning and Mental ability (Part B of Syllabus)	30	30	
<b>Total</b>		<b>120</b>	<b>120</b>	

- v) Part A contains questions from the four subjects namely Biology, Physics, Chemistry and Mathematics. Candidate can attempt any 2 of the subjects mentioned above.
- vi) Tentative syllabus for the written examination for the recruitment of **Forester** is annexed at Annexure-1 and 2.

## Part A Syllabus

(Post- Forester)

### I. PHYSICS

#### 1. Physical World and Measurement

##### **Physical World**

Physics-scope and excitement; nature of physical laws; Physics, technology and society.

##### **Units and Measurements**

Need for measurement: Units of measurement; systems of units; SI units, fundamental and derived units. Length, mass and time measurements; accuracy and precision of measuring instruments; errors in measurement, significant figures. Dimensions of physical quantities, dimensional analysis and its applications.

#### 2. Kinematics

##### **Motion in a Straight Line**

Frame of reference. Motion in a straight line: Position-time graph, speed and velocity.

Elementary concepts of differentiation and integration for describing motion, uniform and non-uniform motion, average speed and instantaneous velocity, uniform accelerated motion, velocity-time and position-time graphs.

Relations for uniformly accelerated motion (graphical treatment)

##### **Motion in a Plane**

Scalar and vector quantities: Position and displacement vectors, general vectors and notation, equality of vectors, multiplication of vectors by a real number; addition and subtraction of vectors. Relative velocity.

Unit vector: Resolution of a vector in a plane - rectangular components. *Scalar and vector product of vectors*. Motion in a plane. Cases of uniform velocity and uniform acceleration-projectile motion. Uniform circular motion.

### **3. Laws of Motion**

Intuitive concept of force. Inertia. Newton's first law of motion; momentum and Newton's second law of motion; impulse: 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, lubrication. Dynamics of uniform circular motion: Centripetal force, examples of circular motion (vehicle on level circular road. vehicle on banked road).

### **4. Work, Energy and Power**

Work done by a constant force and a variable force; kinetic energy, work-energy theorem, power. Notion of potential energy, potential energy of a spring, conservative forces: conservation of mechanical energy (kinetic and potential energies); non-Conservative forces, various forms of energy, motion in a vertical circle; elastic and inelastic collisions in one and two dimensions.

### **5. Motion of System of Particles and Rigid Body**

Centre of mass of a two-particle system, momentum conservation and centre of mass motion. Centre of mass of a rigid body; centre of mass of uniform rod. Moment of a force, torque, angular momentum, Law of conservation of angular momentum and its applications. Equilibrium of rigid bodies, rigid body rotation and equations of rotational motion, comparison of linear and rotational motions; moment of inertia, radius of gyration. Values of moments of inertia for simple geometrical objects (no derivation). Statement of parallel and perpendicular axes theorems and their applications.

### **6. Gravitation**

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

## 7. Properties of Bulk Matter

### Mechanical Properties of Solids

Elastic behaviour, of solids, Stress-strain relationship, Hooke's law, Young's modulus, bulk modulus, shear modulus of rigidity, Poisson's ratio; elastic energy.

### Mechanical Properties of Fluids

Pressure due to a fluid column, Pascal's law and its applications (hydraulic lift and hydraulic brakes). Effect of gravity on fluid pressure. Viscosity, Stokes' law, terminal velocity, streamline and turbulent flow. Critical velocity. Bernoulli's theorem and its applications. Surface energy and surface tension, angle of contact, excess of pressure, across curved surface, application of surface tension ideas to drops, bubbles and capillary rise,

### Thermal Properties of Matter

Heat, temperature, thermal expansion; thermal expansion of solids, liquids and gases, anomalous expansion of water, specific heat Capacity:  $C_p$ ,  $C_v$ ; calorimetry; change of state-latent heat capacity. Heat transfer-conduction, convection radiation and thermal Conductivity, *Qualitative idea of Blackbody radiation*, Stefan's law, Wein's displacement law, Green House effect.

## 8. Thermodynamics

Thermal equilibrium and definition of temperature (zeroth law of thermodynamics). Heat, work and internal energy. First law of thermodynamics. Isothermal and adiabatic processes.

Second law of thermodynamics: reversible and irreversible processes. Heat engines and refrigerators.

## 9. Behaviour of Perfect Gas and Kinetic Theory of gases

Equation of state of a perfect gas, work done on compressing a gas. Kinetic theory of gases- assumptions, concept of pressure. Kinetic interpretation of temperature; rms speed of gas molecules; degrees of freedom, law of equipartition of energy (statement only) and application to

specific heat capacities of gases, concept of mean free path, Avogadro's number.

## **10. Oscillations and Waves**

Periodic motion – time period, frequency, displacement as a function of time.

Periodic functions. Simple harmonic motion (S.H.M) and its equation; these; oscillations of a loading 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 (qualitative ideas only), resonance.

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

## **11. Electrostatics**

Electric Charges; charging by induction, basic properties of electric charge (addition of charges, quantisation of charges and their Conservation) Coulomb's law-force between two point charges, forces between multiple charges; superposition principle and continuous charge distribution. Electrical field, electric field due to a point charge, electric field due to system of charge, physical significance of electric field, electric field lines; electric dipole, electric field due to a dipole;(on its axis, on equatorial plane) physical significance of dipoles; torque on a dipole in uniform electric field. Electric field due to continuous charge distribution. Electric flux, statement of Gauss's theorem proof of Gauss's theorem for a charge enclosed in sphere, and its applications to find electric field due to infinitely long straight wire, uniformly charged infinite thin plane sheet and uniformly charged thin spherical shell (Field inside and outside). Electric potential, potential difference, electric potential due to a point charge, potential due to an electric dipole with special cases for axis and equatorial plane and system of charges; equipotential surfaces, its properties, relation between field and potential electrical potential energy of a system of two point charges, potential energy in external field and of electric dipole in an electrostatic field. Conductors and insulators, electrostatics of conductors, free charges

and bound charges inside a conductor. Electrostatic shielding its uses, Dielectrics and electric polarisation, capacitors and capacitance, combination of capacitors in series and in parallel, capacitance of a parallel plate capacitor with and without dielectric medium between the plates, energy stored in a capacitor.

## **12. Current Electricity**

Electric current, flow of electric charges in a metallic conductor, drift velocity, drift of electron mobility and their relation with electric current: Ohm's law, electrical resistance. V-I characteristics (linear and non linear), electrical energy and power, electrical resistivity and conductivity. Carbon resistors, colour code for carbon resistors; series and parallel combinations of resistors; temperature dependence of resistance and resistivity. Internal resistance of a cell, potential difference and emf of cell, combination of cells in series and in parallel. Kirchhoff's laws and simple applications of Wheatstone bridge, meter bridge. Potentiometer-principle and its applications to measure potential difference and for comparing emf of two cells, measurement of internal resistance of a cell.

## **13. Magnetic Effects of Current and Magnetism**

Concept of magnetic field. Oersted's experiment; Biot-savart law and its application to find magnetic field on the axis of a current carrying circular loop, Ampere's circuital law (no proof) and its applications to infinitely long straight wire, straight and toroidal solenoids. Force on a moving charge in uniform magnetic and electric fields. Cyclotron. Force on a current-carrying conductor in a uniform magnetic field. Force between two parallel current-carrying conductors, definition of ampere. Torque experienced by a current loop in uniform magnetic field; moving coil galvanometers- its current sensitivity and conversion to ammeter and voltmeter. Current loop as a magnetic dipole and its magnetic dipole moment. Magnetic dipole moment of a revolving electron. Magnetic field intensity due to a magnetic dipole (Bar magnet) along its axis and perpendicular to its axis. Torque on a magnetic dipole (bar magnet) in a uniform magnetic field; bar magnet as an equivalent solenoid, magnetic field lines; magnetism and Gauss's law; Earth's magnetic field and magnetic elements, magnetisation and magnetic intensity, magnetic properties of materials, Para-, dia- and ferromagnetic

substances with examples, Electromagnets and factors affecting their strengths. Permanent magnets.

#### **14. Electromagnetic Induction and Alternating Currents**

Electromagnetic induction, Faraday's and Henry experiments, magnetic flux, Faraday laws, induced emf and current, Lenz's Law and conservation of energy, motional emf, Eddy currents: Self and mutual inductance. Alternating current, peak and rms value of alternating current/voltage; reactance and impedances; phasors, ac applied across resistance, ac applied across inductor, ac applied across capacitor, ac applied across LCR, LC oscillations, across inductor, ac applied across capacitor, ac applied across LCR oscillations, (qualitative treatment only), LCR series circuit resonance; power in AC circuit, wattless current. AC generator and transformer.

#### **15. Electromagnetic Waves**

Need for displacement current, Electromagnetic waves and their characteristics (qualitative ideas only). Transverse nature of electromagnetic waves. Electromagnetic spectrum (Radio waves, Radio-microwaves, infra-red, visible, ultraviolet, X-rays, gamma rays) including elementary facts about their uses.

#### **16. Optics**

Reflection of light, spherical mirrors, mirror formula. Refraction of light, total internal reflection and its applications, optical fibers, refraction at spherical surfaces, refraction by lens, lenses, thin lens formula/equation, lens-maker's formula. Magnification, power of a lens, combination of thin lenses in contact, combination of lens and mirror. Refraction and dispersion of light through a prism. Some natural phenomenon due to sunlight, Scattering of light-blue colour of the sky and reddish appearance of the sun at sunrise and sunset. Microscopes and astronomical telescopes (reflecting and refracting) and their magnifying powers. Wave front and Huygens' Principle, reflection and refraction of Plane Waves using Huygens Principle.

## **II. CHEMISTRY**

### **1. Some Basic Concepts of Chemistry**

General Introduction: Importance and scope of chemistry. 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 reactions, stoichiometry and calculations based on stoichiometry.

### **2. Structure of Atom**

Bohr's model and its limitations, concept of shells and subshells, dual nature of matter and light, de Broglie's relationship, Heisenberg uncertainty principle, concept of orbitals, quantum numbers, shapes of s, Pauli's exclusion principle and Hund's rule, electronic configuration of atoms, stability of half-filled and completely filled orbitals.

### **3. Classification of Elements and Periodicity**

Modern periodic law and the present form of periodic table, periodic trends in properties of elements-atomic radii, ionic, inert gas radii, ionization enthalpy, electron gain enthalpy, electronegativity, valency. Nomenclature of elements with atomic number greater than 100

### **4. Chemical Bonding and Molecular Structure**

Valence electrons, ionic bond, covalent bond, bond parameters, Lewis structure, polar character of covalent bond, ionic character of ionic bond, valence bond theory, resonance, geometry of covalent molecules, VSEPR theory, concept of hybridization, involving s, p and d orbitals and shapes of some simple molecules, molecular orbital theory of homonuclear diatomic molecules (qualitative idea only), hydrogen bond.

### **5. States of Matter: Gases and Liquids**

Three states of matter, intermolecular interactions, types of bonding, melting and boiling points, role of gas laws in elucidating the concept of the molecule, Boyle's law, Charles law, Gay Lussac's law, Avogadro's law, ideal behaviour, empirical derivation of gas equation, Avogadro's number,



ideal gas equation. Deviation from ideal behaviour, liquefaction of gases, critical temperature, kinetic energy and molecular speeds (elementary idea)  
Liquid State: vapour pressure, viscosity and surface tension (qualitative idea only, no mathematical derivations)

## **6. Chemical Thermodynamics**

Concepts of System and types of systems, surroundings, work, heat, energy, extensive and intensive properties, state functions. 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, solution and dilution. Second law of Thermodynamics (brief introduction). Introduction of entropy as a state function, Gibb's energy change for spontaneous and non-spontaneous processes, criteria for equilibrium. Third law of thermodynamics (brief introduction).

## **7. Equilibrium**

Equilibrium in physical and chemical process, dynamic nature of equilibrium, law of mass action, equilibrium constant, factors affecting equilibrium-Le Chatelier's principle, ionic equilibrium-ionization of acids and bases, strong and weak electrolytes, degree of ionization, ionization of poly basic acids, acid strength, concept of pH, Henderson Equation, hydrolysis of salts (elementary idea), buffer solution, solubility product, common hydrolysis of salts (elementary idea), buffer solution, solubility product, common ion effect (with illustrative examples).

## **8. Redox Reactions**

Concept of oxidation and reduction, redox reactions, oxidation number, balancing redox reactions, in terms of loss and gain of electrons and change in oxidation number, applications of redox reactions.

## **9. Hydrogen**

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, heavy water, hydrogen peroxide- preparation, reactions and structure and use; hydrogen as a fuel.

### **10. s-Block Elements (Alkali and Alkaline Earth Metals)**

Group 1 and Group 2 Elements General introduction, 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 radii), trends in chemical reactivity with oxygen, water, hydrogen and halogens, uses. Preparation and Properties of some important Compounds: Sodium Carbonate, Sodium chloride, Sodium Hydroxide and Sodium Hydrogencarbonate, Biological importance of Sodium and Potassium. Calcium Oxide and Calcium Carbonate and their industrial uses, biological importance of Magnesium and Calcium.

### **11. p-Block Elements**

General Introduction to p-Block Elements Group 13 Elements: General introduction, electronic configuration, occurrence, variation of properties, oxidation states, trends in chemical reactivity, anomalous properties of first element of the group, Boron- physical and chemical properties, some important compounds, Borax, Boric acid, Boron Hydrides, Aluminium: Reactions with acids and alkalis, uses Group 14 Elements: General introduction, electronic, configuration, occurrence, variation of properties, oxidation states, trends in chemical reactivity, anomalous behaviour of first elements. Carbon-catenation, allotropic forms, physical and chemical properties; uses of some important compounds: oxides. Important compounds of Silicon and a few use: Silicon Tetrachloride, Silicones, Silicates and Zeolites, their uses.

### **12. Organic Chemistry-Some Basic Principles and Techniques**

General introduction, methods of purification, qualitative and quantitative analysis, classification and IUPAC nomenclature of organic compounds. Electronic displacements in a covalent bond: inductive effect, electromeric effect, resonance and hyper conjugation. Homolytic and heterolytic fission of a covalent bond: free radicals, carbocations, carbanions, electrophiles and nucleophiles, types of organic reactions.

### 13. Hydrocarbons

Classification of Hydrocarbons Aliphatic Hydrocarbons:

Alkanes-Nomenclature, isomerism, conformation (ethane only), physical properties, chemical reactions including free radical mechanism of halogenation, combustion and pyrolysis. Alkenes-Nomenclature, structure of double bond (ethene), geometrical isomerism, physical properties, methods of preparation, chemical reactions: addition of hydrogen, halogen, water, hydrogen halides (Markownikov's addition and peroxide effect), ozonolysis, oxidation, mechanism of electrophilic addition. Alkynes-Nomenclature, structure of triple bond (ethyne), physical properties, methods of preparation, chemical reactions: acidic character of alkynes, addition reaction of  $\text{H}_2$ , halogens, hydrogen halides and water. Aromatic Hydrocarbons: Introduction, IUPAC nomenclature, benzene: resonance, aromaticity, chemical properties: mechanism of electrophilic substitution. Nitration, sulphonation, halogenation, Friedel Craft's alkylation and acylation, directive influence of functional group in monosubstituted benzene. Carcinogenicity and toxicity.

### 14. Environmental Chemistry

Environmental pollution-air, water and soil pollution, chemical reactions in atmosphere, smog, major atmospheric pollutants, acid rain, ozone and its reactions, effects of depletion of ozone layer, greenhouse effect and global warming-pollution due to industrial wastes, green chemistry as alternative tool for reducing pollution, strategies for control of environmental pollution.

### 15. Solid State

Classification of solids based on different binding forces: molecular, ionic, covalent and metallic solids, amorphous and crystalline solids (elementary idea). Unit cell in two dimensional and three dimensional lattices, calculation of density of unit cell, packing in solids, packing efficiency, voids, number of atoms per unit cell in a cubic unit cell, point defects, electrical and magnetic properties. Band theory of metals, conductors, semiconductors and insulators and  $n$  and  $p$  type semiconductors.

### 16. Solutions

Types of solutions, expression of concentration of solutions of solids in liquids, solubility of gases in liquids, solid solutions, colligative properties - relative lowering of vapour pressure, Raoult's Law, elevation of B.P., depression of freezing point, osmotic pressure, determination of molecular masses using colligative properties, abnormal molecular mass. Van't Hoff factor.

### **17. Electrochemistry**

Redox reactions; conductance in electrolytic solutions, specific and molar conductivity, variations of conductivity with concentration, Kohlrausch's Law, electrolysis and laws of electrolysis (elementary idea) dry cell, electrolytic cells and Galvanic cells; lead accumulator, EMF of a cell, standard electrode potential, Nernst equation and its application to chemical cells, fuel cells; corrosion. Relation between Gibbs Energy change and EMF of cell.

### **18. Chemical Kinetics**

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.

### **19. Surface Chemistry**

Absorption, physisorption and chemisorption; factors affecting adsorption of gases on solids; catalysis; homogeneous and heterogeneous, activity and selectivity; enzyme catalysis; colloidal state: distinction between true solutions, colloids and suspensions; lyophilic, lyophobic, multimolecular and macromolecular/colloids; properties of colloids; Tyndall effect, Brownian movement, electrophoresis, coagulation; emulsion-types of emulsions.

### **20. General Principles and Processes of Isolation of Elements**

Principles and methods of extraction – concentration, oxidation, reduction electrolytic method and refining; occurrence and principles of extraction of aluminum, copper, zinc and Iron.

## **21. p-Block Element**

**Group-15 Elements:** General introduction, electronic configuration, occurrence, oxidation states, trends in physical and chemical properties; Nitrogen preparation properties and uses; compounds of Nitrogen: preparation and properties of Ammonia and Nitric Acid, Oxides of Nitrogen (Structure only); Phosphorus - allotropic forms, compounds of Phosphorus: Preparation and properties of Phosphine, Halides and Oxoacids (elementary idea only).

**Group16 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).

**Group 18 elements:** General introduction, electronic configuration. Occurrence, trends in physical and chemical properties, uses.

## **22. 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, electronic configuration, oxidation states, chemical reactivity and lanthanoid contraction and consequences.

**Actenoids** - Electronic configuration, oxidation states.

## **23. Coordination Compounds**

Coordination compounds - introduction, ligands, coordination number, colour, magnetic properties and shapes, IUPAC nomenclature of mononuclear coordination compounds, bonding; Werner's theory VBT, CFT, Isomerism (structure and stereo) importance of coordination compounds (in qualitative analysis, extraction of metals and biological systems).

#### **24. Haloalkanes and Haloarenes.**

**Haloalkanes:** Nomenclature, nature of C-X bond, physical and chemical properties, mechanism of substitution reactions, optical rotation.

**Haloarenes:** Nature of C-X bond, substitution reactions (directive influence of halogen for monosubstituted compounds only) Uses and environmental effects of – dichloromethane, trichloromethane.

#### **25. Alcohols, Phenols and Ethers**

**Alcohols:** Nomenclature, methods of preparation, physical and chemical properties (of primary alcohols only); identification of primary, secondary and tertiary alcohols; mechanism of dehydration, uses, with special reference to - methanol and ethanol. **Phenols:** Nomenclature, methods of preparation, physical and chemical properties, acidic nature of phenol, electrophilic substitution reactions, uses of phenols.

**Ethers:** Nomenclature, methods of preparation, physical and chemical properties, uses.

#### **26. Aldehydes, Ketones and Carboxylic Acids**

**Aldehydes and Ketones:** Nomenclature, nature of carbonyl group, methods of preparation, physical and chemical properties, and mechanism of nucleophilic addition, reactivity of alpha hydrogen in aldehydes; uses.

**Carboxylic Acids:** Nomenclature, acidic nature, methods of preparation, physical and chemical properties; uses.

#### **27. Organic compounds containing Nitrogen**

**Amines:** Nomenclature, classification, structure, methods of preparation, physical and chemical properties, uses, identification of primary, secondary and tertiary amines.

**Cyanides and Isocyanides** - will be mentioned at relevant places in context.

**Dizonium Salts:** Preparation, chemical reactions and importance in synthetic organic chemistry.

## 28. Biomolecules

**Carbohydrates** - Classification (aldoses and ketoses), monosaccharides (glucose and fructose), oligosaccharides (sucrose, lactose, maltose), polysaccharides (starch, cellulose, glycogen); importance

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

**Vitamins:** Classification and functions.

**Harmones:**Elementary idea (excluding structure)

**Nucleic Acids:** DNA & RNA .

## 29. Polymers

Classification - natural and synthetic, methods of polymerization (addition and condensation), copolymerization. Some important polymers; natural and synthetic like polythene, nylon, polyesters, bakelite, rubber. Biodegradable and Non- Biodegradable Polymers.

## 30. Chemistry in everyday life :

1. **Chemicals in medicines** analgesic, tranquilizers, antiseptics, disinfectants, antimicrobials, antifertility drugs, antibiotics, antacids, antihistamines.

2. **Chemicals in food-** preservatives, artificial sweetening agents. Elementary idea of antioxidants.

3. **Cleansing agents-** soaps and detergents, cleansing action.

### **III. MATHEMATICS**

#### **1. Sets and Functions**

**Sets:** Sets and their representations. Empty set, Finite & Infinite sets, Equal sets, Subsets, Subsets of the set of real numbers especially intervals (with notations). Power set. Universal set. Venn diagrams. Union and Intersection of sets. Difference of sets. Complement of a set, Properties of Complement .

**Relations & Functions:** Ordered pairs, Cartesian product of sets. Number of elements in the Cartesian product of two finite sets. Cartesian product of the reals with itself (upto  $R \times R \times R$ ). Definition of relation, pictorial diagrams, domain, codomain and range of a relation. Function as a special type of relation. Pictorial representation of a function, domain, co-domain and range of a function. Real valued function, domain and range of these functions, constant, identity, polynomial, rational, modulus, signum and greatest integer functions with their graphs. Sum, difference, product and quotients of functions.

**Trigonometric Functions:** Positive and negative angles. Measuring angles in radians and in degrees and conversion from one measure to another. Definition of trigonometric functions with the help of unit circle. Truth of the identity  $\sin^2x + \cos^2x = 1$ , for all  $x$ . Signs of trigonometric functions. Domain and range of trigonometric function and their graphs. Expressing  $\sin(x \pm y)$  and  $\cos(x \pm y)$  in terms of  $\sin x$ ,  $\sin y$ ,  $\cos x$  &  $\cos y$  and their simple applications.

#### **2. Algebra**

**Complex Numbers and Quadratic Equations:** Need for complex numbers, especially  $\sqrt{-1}$ , to be motivated by inability to solve some of the quadratic equation. Algebraic properties of complex number. Argand plane and polar representation of complex numbers. Statement of Fundamental



Theorem of Algebra, solution of quadratic equations (with real coefficients) in the complex number system. Square root of a complex number.

**Linear Inequalities:** Linear inequalities. Algebraic solutions of linear inequalities in one variable and their representation on the number line.

**Permutations & Combinations :** Fundamental principle of counting, Factorial  $n(n!)$  Permutations and combinations, derivation of formulae for  $C(n, r)$  and  $P(n, r)$  their connections, simple applications.

**Binomial Theorem :** History, statement and proof of the binomial theorem for positive integral indices. Pascal's triangle. General and middle term in binomial expansion, simple applications.

**Sequence and series:** Sequence and Series. Arithmetic Progression (A.P.), Arithmetic Mean (A.M.) , Geometric Progression ( G.P.), general term of a G.P, sum of  $n$  terms of a G.P. Infinite G.P. and its sum, geometric mean (G.M), relation between A.M. and G.M.

**Matrices:** Concept, notation, order, equality, types of matrices, zero and identity matrix, transpose of a matrix, symmetric and skew symmetric matrices. Operation of matrices. Addition and multiplication and multiplication with a scalar. Simple properties of addition, multiplication and scalar multiplication. Noncommutativity of multiplication of matrices and existence of non-zero matrices whose product is the zero matrix (restrict to square matrices of order 2). Concept of elementary row and column operations. Invertible matrices and proof of the uniqueness of inverse, if it exists; (Here all matrices will have real entries).

**Determinants:** Determinant of a square matrix (up to  $3 \times 3$  matrices), properties of determinants, minors, cofactors and applications of determinants in finding the area of a triangle. Adjoint and inverse of a square matrix. Consistency, inconsistency and number of solutions of system of linear equation by examples, solving system of linear equations in two or three variables (having unique solution) using inverse of a matrix.

### **3. Coordinate Geometry**

**Straight Lines** :Brief recall of two dimensional geometry from earlier classes. Shifting of origin. Slope of a line and angle between two lines .Various forms of equations of a line: parallel to axis, point–slope form, slop–intercept form, two–pointform, intercept form and normal form. General equation of a line. Equation of family of lines passing through the point of intersection of two lines. Distance of a point from a line.

**Conic Sections**:Sections of a cone: circles, ellipse, parabola, hyperbola, a point, a straight line and a pair of intersecting lines as a degenerated case of a conic section. Standard equations and simple properties of parabola, ellipse and hyperbola. Standard equations of a circle.

### **4. Calculus**

**Limits and Derivatives**:Derivative introduced as rate of change both as that of distance function and geometrically. intuitive idea of limit. Limits of polynomials and rational functions trigonometric, exponential and logarithmic functions. Definition of derivative, relate it to slope of tangent of the curve, derivative of sum, difference, product and quotient of functions. Derivatives of polynomial and trigonometric functions.

**Continuity and Differentiability**: Continuity and Differentiability, derivative of composite functions, chain rule, derivative of inverse trigonometric functions, derivative of implicit function.

Concepts of exponential and logarithmic functions. Derivatives of logarithmic and exponential functions. Logarithmic, differentiation, derivative of functions expressed in parametric forms. Second order derivatives.

**Applications of Derivatives**:Applications of derivatives: rate of change, increasing/decreasing functions, tangents and normal.

#### **Integrals:**

Integration as inverse process of differentiation. Integration of a variety of functions by substitution, by partial fractions and by parts, Evaluation of simple integrals of the following types and problems based on them.

## **5. Statistics and Probability**

**Statistics:** Measure of Dispersion: Range, mean deviation, variance and standard deviation of ungrouped data.

**Probability:** Random experiments: outcomes, sample spaces (set representation). Events: Occurrence of events, 'not', 'and' & 'or' events, exhaustive events, mutually exclusive events. Axiomatic (set theoretic) probability, connections with others theories of earlier classes. Probability of an event, probability of 'not', 'and' & 'or' events, Conditional probability, multiplication theorem on probability, independent events; total probability, Binomial probability distribution.

## **6. VECTORS AND THREE DIMENSIONAL GEOMETRY**

**Vectors:** Vectors and scalars, magnitude and direction of a vector. Direction cosines and direction ratios of vectors. Types of vectors (equal, unit, zero, parallel and collinear vectors), position vector of a point, negative of a vector, components of a vector, addition of vectors, multiplication of a vector by a scalar, position vector of a point dividing a line segment in a given ratio. Definition, Geometrical interpretation, properties and application of scalar (dot) product of vectors, vector (cross) product of vectors, scalar triple product of vectors.

### **Three-dimensional Geometry:**

Introduction to Three-dimensional Geometry: Coordinate axes and coordinate planes in three dimensions. Coordinates of a point. Distance between two points and section formula. Direction cosines and direction ratios of a line joining two points. Cartesian equations and vector equation of a line, coplanar and skew lines, shortest distance between two lines. Cartesian and vector equation of a plane. Angle between two lines.

## **IV. BIOLOGY**

### **1. Reproduction in organisms:**

Reproduction, a characteristic feature of all organism for continuation of species; Modes of reproduction-Asexual and sexual reproduction; Modes – Binary fission, sporulation, budding, gemmule, fragmentation; vegetative propagation in plants.

### **2. Sexual reproduction in flowering plants:**

Flower structure; Development of male and female gametophytes; Pollination types, agencies and examples; Outbreeding devices; Pollen-Pistil interaction; Double fertilization; Post fertilization events-Development of endosperm and embryo, Development of seed and formation of fruit; Special modes-apomixis, parthenocarpy, polyembryony; Significance of seed dispersal and fruit formation.

### **3. Heredity and variation:**

Mendelian Inheritance; Deviations from Mendelism-Incomplete dominance, Codominance, Multiple alleles and Inheritance of blood groups, Pleiotropy; Elementary idea of polygenic inheritance; Chromosome theory of inheritance; Chromosomes and genes; Sex determination-In birds, honey bee; Linkage and crossing over; Sex linked inheritance – Haemophilia, Colour blindness; Mendelian disorders in humans- Thalassemia; Chromosomal disorders in humans; Down's syndrome, Turner's and Klinefelter's syndromes.

### **4. Molecular Basis of Inheritance:**

Search for genetic material and DNA as genetic material; Structure of DNA and RNA; DNA packaging; DNA replication; Central dogma; Transcription, genetic code, translation; Gene expression and regulation- Lac Operon; Genome and human genome project; DNA finger printing.

### **5. Evolution:**

Origin of life; Biological evolution and evidences for biological evolution

(Paleontological, Comparative anatomy, embryology and molecular evidence); Darwin's contribution, Modern Synthetic theory of Evolution; Mechanism of evolution-Variation (Mutation and Recombination) and Natural Selection with examples, types of natural selection; Gene flow and genetic drift; Hardy-Weinberg's principle; Adaptive Radiation; Human evolution.

## **6. Human Health and Disease:**

Pathogens/ parasites causing human diseases (Malaria, Filariasis, Ascariasis, Typhoid, Pneumonia, common cold, amoebiasis, dengue, chickengunia, ring worm); Basic concepts of immunology-vaccines; Cancer, HIV and AID's; Adolescence, drug and alchochol abuse.

## **7. Strategies for Enhancement in Food Production**

Improvement in food production: plant breeding, tissues culture, single cell protein, Bifortification, Apiculture and animal husbandary.

## **8. Microbes in human welfare:**

In household food processing, industrial production, sewage treatment, energy generation and Microbes as biocontrol agents and biofertilizers, Antibiotics production.

## **9. Organisms and populations**

Organisms and environment: Habitat and niche; Population and ecological adaptations; Population interactions-mutualism, competition, predation, parasitism; Population attributes-growth, birth rate and death rate, age distribution.

## **10. Ecosystem:**

Patterns, components; productivity and decompositions; Energy flow; Pyramids of number, biomass, energy; Nutrients cycling (carbon and phosphorous); Ecological succession; Ecological Services-Carbon fixation, pollination, oxygen release.

## **11. Biodiversity and Conservation:**

Concepts of Biodiversity; Patterns of Biodiversity; Importance of Biodiversity; Loss of Biodiversity; Biodiversity conservation; Hotspots, endangered organisms, extinction, Red Data Book, biosphere reserves, National parks and sanctuaries.

## **12. Environmental issues:**

Air pollution and its control; Water pollution and its control; Agrochemicals and their effects; Solid waste management; Radioactive waste management; Greenhouse effect and global warming; Ozone depletion; Deforestation; Any three case studies as success stories addressing environmental issues.

## **13. The Living World**

What is living? Biodiversity; Need for classification; three domains of life; taxonomy and systematics; concept of species and taxonomical hierarchy; binomial nomenclature; tools for study of taxonomy museums, zoological parks, herbaria, botanical gardens.

## **14. Biological Classification**

Five kingdom classification; Salient features and classification of Monera, Protista and Fungi into major groups: Lichens, Viruses and Viroids.

## **15. Plant Kingdom**

Salient features and classification of plants into major groups - Algae, Bryophyta, Pteridophyta, Gymnospermae and Angiospermae (three to five salient and distinguishing features and at least two examples of each category); Angiosperms - classification upto class, characteristic features and examples.

## **16. Animal Kingdom**

Salient features and classification of animals, non-chordates up to phyla level and chordates up to class level (three to five salient features and at least two examples of each category). (No live animals or specimen should be displayed.)

## **17. Morphology of Flowering Plants**

Morphology and modifications: Morphology of different parts of flowering plants: root, stem, leaf, inflorescence, flower, fruit and seed (to be dealt along with the relevant experiment of the Practical Syllabus).

### **18. Anatomy of Flowering Plants**

Anatomy and functions of different tissues and tissue systems.

### **19. Structural Organisation in Animals**

Animal tissues; Morphology, anatomy and functions of different systems (digestive, circulatory, respiratory, nervous and reproductive) of an insect (cockroach). (a brief account only)

### **20. Cell-The Unit of Life**

Cell theory and cell as the basic unit of life: Structure of prokaryotic and eukaryotic cells; Plant cell and animal cell; cell envelope; cell membrane, cell wall; cell organelles - structure and function; endomembrane system, endoplasmic reticulum, golgi bodies, lysosomes, vacuoles; mitochondria, ribosomes, plastids, microbodies; cytoskeleton, cilia, flagella, centrioles (ultrastructure and function); nucleus.

### **21. Biomolecules**

Chemical constituents of living cells: biomolecules, structure and function of proteins, carbohydrates, lipids, nucleic acids; Enzymes types, properties, enzyme action.

### **22. Cell Cycle and Cell Division**

Cell cycle, mitosis, meiosis and their significance

### **23. Transport in Plants**

Movement of water, gases and nutrients; cell to cell transport, diffusion, facilitated diffusion, active transport; plant-water relations, imbibition, water potential, osmosis, plasmolysis; long distance transport of water - Absorption, apoplast, symplast, transpiration pull, root pressure and guttation; transpiration, opening and closing of stomata; Uptake and translocation of mineral nutrients - Transport of food, phloem transport, mass flow hypothesis.

## **24. Mineral Nutrition**

Essential minerals, macro- and micronutrients and their role; deficiency symptoms; mineral toxicity; elementary idea of hydroponics as a method to study mineral nutrition; nitrogen metabolism, nitrogen cycle, biological nitrogen fixation.

## **25. Photosynthesis in Higher Plants**

Photosynthesis as a means of autotrophic nutrition; site of photosynthesis, pigments involved in photosynthesis (elementary idea); photochemical and biosynthetic phases of photosynthesis; cyclic and non-cyclic photophosphorylation; chemiosmotic hypothesis; photorespiration; C3 and C4 pathways; factors affecting photosynthesis.

## **26. Respiration in Plants**

Exchange of gases; cellular respiration - glycolysis, fermentation (anaerobic), TCA cycle and electron transport system (aerobic); energy relations - number of ATP molecules generated; amphibolic pathways; respiratory quotient.

## **27. Plant - Growth and Development**

Seed germination; phases of plant growth and plant growth rate; conditions of growth; differentiation, dedifferentiation and redifferentiation; sequence of developmental processes in a plant cell; growth regulators - auxin, gibberellin, cytokinin, ethylene, ABA; seed dormancy; vernalisation; photoperiodism.



## Annexure-2

### Part B Syllabus

**General Knowledge, English, Punjabi, Logical Reasoning and Mental Ability.**

<b>Sr. No.</b>	<b>Indicative Contents of Syllabus</b>	<b>Weightage (Approx.)</b>
1	<p><b>General Knowledge and Current affairs of National and International importance including:</b></p> <ul style="list-style-type: none"><li>(i) Political issues,</li><li>(ii) Environment issues,</li><li>(iii) Current Affairs,</li><li>(iv) Science and Technology,</li><li>(v) Economic issues,</li><li>(vi) History of Punjab-14<sup>th</sup> century onwards</li><li>(vii) History of India with special reference to Indian freedom struggle movement.</li><li>(viii) Sports,</li><li>(ix) Cinema and Literature.</li></ul>	10
2	<p><b>Logical Reasoning &amp; Mental Ability:</b></p> <p>Verbal reasoning : Coding, Decoding, Analogy, Classification, Series, Direction sense test, relations, mathematical operations, time test, odd man out problems.</p> <p>Non Verbal reasoning : Series, Analogy and Classification.</p> <p>Basic numerical skills, Percentage, Number system, LCM and HCF, Ratio and Proportion, Number series, Average, Problems based on Ages, Profit &amp; Loss, Partnership and Mixture, Simple and Compound Interest, Work and Time, Time and Distance, Mensuration and Data Interpretation.</p>	10

3	<p><b>English:-</b></p> <p>Basic Grammar, Subject and Verb, Adjectives and Adverbs, Synonyms, Antonyms, One Word Substitution, Fill in the Blanks, Correction in Sentences, Idioms and their meanings, Spell Checks, Adjectives, Articles, Prepositions, Direct and Indirect Speech, Active and Passive Voice, Correction in Sentences, etc.</p>	5
4	<p><b>ਪੰਜਾਬੀ:-</b></p> <p>ਸੁੱਧ-ਅਸੁੱਧ, ਸ਼ਬਦਜੋੜ, ਅਗੇਤਰ ਅਤੇ ਪਿਛੇਤਰ, ਸਮਾਨਾਰਥਕ/ਵਿਰੋਧੀਸ਼ਬਦ, ਨਾਂਵ, ਪੜਨਾਂਵ ਅਤੇ ਕਿਰਿਆ ਦੀਆਂ ਕਿਸਮਾਂ ਤੇ ਸਹੀ ਵਰਤੋਂ, ਲਿੰਗ ਅਤੇ ਵਚਨ, ਪੰਜਾਬੀ ਅਖਾਣ ਤੇ ਮੁਹਾਵਰੇ, ਅੰਗਰੇਜੀ ਤੋਂ ਪੰਜਾਬੀ ਅਨੁਵਾਦ ਅਤੇ ਬਹੁਤੇ ਸ਼ਬਦਾਂ ਦੀ ਥਾਂ ਇੱਕ ਸ਼ਬਦ ਆਦਿ।</p>	5
	<b>Maximum Marks</b>	30

Note:-a) The distribution of marks/question in each section is indicative. It may vary slightly.

b) The syllabus is broadly classified as above but may vary to some extent.