

# UGET 2007

**TEST PATTERN** - The test duration is of 2.30 hours and consists of 240 multiple choice questions (MCQ) of the objective type. The question paper will be in English. The approximate distribution of questions is as follows: Physics - 60 questions, Chemistry - 60 questions, Biology - 80 questions, English & General Aptitude - 40 questions.

## PHYSICS - PART I

### DYNAMICS

**Newton's laws of motion:** First law of motion - force and inertia with examples - momentum - second law of motion, derivation of  $F=ma$ , mention of spring force  $F=kx$ , mention of basic forces in nature - impulse and impulsive forces with examples - second law as applied to variable mass situation - third law of motion - Identifying action and reaction forces with examples - derivation of law of conservation of momentum with examples in daily life - principle of rocket propulsion - inertial and non-inertial frames - apparent weight in a lift and rocket/satellite - problems.

**Fluid Dynamics:** Explanation of streamline and turbulent motion - mention of equation of continuity - mention of expressions for PE, KE and pressure energy of an element of a liquid flowing through a pipe - statement and explanation of Bemoulli's theorem and its application to uplift of an aircraft sprayer.

**Surface tension:** Concept of adhesive and cohesive forces - definition of Surface energy and surface tension and angle of contact - explanation of capillary rise and mention of its expression - mention of application of surface tension to (i) formation of drops and bubbles (ii) capillary action in wick of a lamp (iii) action of detergents.

**Work - power - energy:** Work done by a force -  $F.S$  - unit of work - graphical representation of work done by a constant and variable force - power - units of power - energy - derivation of expression for gravitation potential energy and kinetic energy of a moving body - statement of work - energy theorem - mention of expression for potential energy of a spring - statement and explanation of law of conservation of energy - illustration in the case of a body sliding down on an inclined plane - discussion of special case when  $\theta = 90^\circ$  for a freely falling body - explanation of conservative and non conservative forces with examples - explanation of elastic and inelastic collisions with examples - coefficient of restitution - problems.

**Gravitation:** Statement and explanation of law of gravitation - definition of  $G$  - derivation of relation between  $g$  and  $G$  - mention of expression for variation of  $g$  with altitude, depth and latitude - statement and explanation of

Kepler's laws of planetary motion - definition of orbital velocity and escape velocity and mention of their expressions - satellites - basic concepts of geo-stationary satellites, launching of satellites - IRS and communication satellites - brief explanation of Inertial mass and gravitational mass - weightlessness - remote sensing and essentials of space communication - problems.

**Concurrent Co-planar forces:** Definition of resultant and equilibrant - statement of law of parallelogram of forces - derivation of expression for magnitude and direction of two concurrent coplanar forces - law of triangle of forces and its converse - Lami's theorem - problems.

## HEAT

**Gas laws:** Statement and explanation of Boyle's law and Charle's law - definition of Pressure and Volume Coefficient of a gas - absolute zero - Kelvin scale of temperature - mention of perfect gas equation - explanation of isothermal and adiabatic changes - mention of Van-der-Waal's equation of state for real gases.

**Mode of heat transfer:** Conduction of heat - steady state - temperature gradient - definition of coefficient of thermal conductivity - basic concepts of convection of heat - radiation - properties of thermal radiation - radiant energy - definition of emissivity and absorptivity - perfect black body - statement and explanation of Kirchhoff's law. Newton's law of cooling - Stefan's law - Wien's displacement and Planck's law - qualitative explanation of solar constant and surface temperature of sun - principle and working of total radiation pyrometer - problems.

## GEOMETRICAL OPTICS

**Waves:** Waves around us - brief note on light waves, sound waves, radio waves, micro waves, seismic waves - wave as a carrier of energy - classification of waves. (i) based on medium - mechanical and electromagnetic waves (ii) based on vibration of particles in the medium - Longitudinal & transverse waves - one, two & three dimensional waves with example - definition of wave amplitude, wave frequency, wave period, wavelength and wave velocity - concept of phase of a wave - derivation  $v=f\lambda$  to establish the relation between path difference and phase difference - definition of a progressive wave - and its characteristics - derivation of equation of a progressive wave - different forms of a progressive wave equation - definition of wave intensity - mention of expression of wave intensity and its unit - statement and explanation of principles of superposition of waves with examples - problems.

**Sound:** Properties of sound - speed of sound in a gas - explanation of Newton's formula for speed of sound - correction by Laplace - Newton - Laplace formula - discussion of factors affecting speed i.e. pressure, temperature, humidity and wind - definition of sound intensity - explanation of loudness and its unit - definition of intensity level and its unit - mention of relation between intensity and loudness - distinction between noise and musical note -

characteristics of a musical note - phenomenon of beats and its theory - application of beats (i) to find the frequency of a note (ii) to tune the musical instruments - Doppler effect - derivation of expression for apparent frequency in general case and discussion to special cases - qualitative comparison of Doppler effect in sound and light - problems.

**Refraction at a plane surface:** Refraction through a parallel sided glass slab - derivation of expressions for lateral shift and normal shift (object in a denser medium) - total internal reflection and its applications - optical fibers and its application in communication - problems.

**Refraction through a prism:** Derivation of expression for the refractive index in terms of A and D - dispersion through a prism - experimental - arrangement for pure spectrum - deviation produced by a thin prism - dispersive power - mention of condition for dispersion without deviation - problems.

**Refraction at a spherical surface:** Derivation of the relation - connecting  $n, u, v$  and  $r$  for refraction at a spherical surface (concave towards a point object in a denser medium) derivation of lens maker's formula - power of a lens - magnification - derivation of expression for the equivalent focal length of combination of two thin lenses in contact - mention of expression for equivalent focal length of two thin lenses separated by a distance - problems.

## PHYSICAL OPTICS

**Introduction to Theories of Light:** A brief explanation of Newton's corpuscular theory, Huygen's wave theory and Maxwell's electromagnetic theory - mention of expression for speed of light  $C = 1/\sqrt{\mu_0 \epsilon_0}$ , qualitative explanation of Hertz's experiment - brief explanation of Planck's quantum theory of radiation - dual nature of light.

**Interference:** Explanation of the phenomenon theory of interference - derivation of conditions for constructive and destructive interference.

Young's double slit experiment, derivation of expression for fringe width - qualitative explanation of interference at thin films and Newton's rings - problems.

**Diffraction:** Explanation of the phenomenon - distinction between Fresnel and Fraunhofer diffraction - qualitative explanation of diffraction at single slit and analysis of diffraction pattern (Fraunhofer type) - qualitative explanation of plane diffraction grating at normal incidence - limit of resolution - resolving power - Rayleigh's criterion - definition and mention of expression for resolving powers of microscope and telescope - problems.

**Polarisation:** Explanation of the phenomenon - representation of polarized and unpolarised light - explanation of plane of polarization and plane of vibration - methods of producing plane polarized light : by reflection - Brewster's law, refraction, double refraction, selective absorption - construction and application of polaroids - optical activity - specific rotatory power - construction and working of Laurent's half shade polarimeter - mention of circularly and elliptically polarized light - problems.

**Speed of light:** Michelson's rotating mirror experiment to determine of light - importance of speed of light.

## ELECTROSTATICS

**Electric charges:** Concept of charge - Coulomb's law, absolute and relative permittivity - SI unit of charge.

**Electrostatic Field:** Concept of electric field - definition of field strength - derivation of expression for the field due to an isolated charge, concept of dipole - mention of expression for the field due to a dipole - definition of dipole moment - mention of expression for torque on a dipole - explanation of polarization of a dielectric medium - dielectric strength - concept of lines of force and their characteristics - explanation of electric flux - statement and explanation of Gauss theorem and its applications to derive expressions for electric intensity (a) near the surface of a charged conductor (b) near a spherical conductor - concept of electric potential - derivation of the relation between electric field and potential - derivation of expression for potential due to an isolated charge - explanation of potential energy of a system of charges - problems.

**Capacitors:** Explanation of capacity of a conductor and factors on which it depends - definition of capacitance and its unit - derivation of expression for capacity of a spherical conductor - principle of a capacitor - derivation of expression for capacitance of parallel plate capacitor - mention of expression for capacitance of spherical and cylindrical capacitors - derivation of expression for energy stored in a capacitor - derivation of expression for equivalent capacitance of capacitors in series and parallel - mention of uses of capacitors - problems.

## CURRENT ELECTRICITY

**Electric current:** Microscopic view of current through conductors (random motion of electrons) - explanation of drift velocity and mobility - derivation of expression for current  $I = neAv_d$  - deduction of Ohm's law - origin of resistance - definition of resistivity - temperature coefficient of resistance - concept of super conductivity - explanation of critical temperature, critical field and high temperature superconductors - mention of uses of superconductors - thermistors and mention of their uses - colour code for resistors - derivation of expression for effective resistance of resistances in series and parallel - derivation of expression for branch currents - definition of emf and internal resistance of a cell - Ohm's law applied to a circuit - problems.

**Kirchoff's laws:** Statement and explanation of Kirchoff's laws for electrical network - explanation of Wheastone's network - derivation of the condition for its balance by applying Kirchoff's laws - principle of metre bridge - problems.

**Magnetic effect of electric current:** Magnetic field produced by electric current - statement and explanation of Biot - Savart's (Laplace's) law - derivation of expression for magnetic field at any point on the axis of a circular coil carrying current and hence expression for magnetic field at the centre - current in a circular coil as a magnetic dipole - explanation of magnetic moment of the current loop - mention of expression for the magnetic field due to (i) a straight current carrying conductor (ii) at a point on the axis of a solenoid - basic concepts of terrestrial magnetism - statement and explanation of Tangent law -construction and theory of tangent galvanometer - problems.

**Mechanical effect of electric current:** Mention of expression for force on a charge moving in magnetic field - mention of expression for force on a conductor carrying current kept in a magnetic field - statement of Fleming's left hand rule - explanation of magnetic field strength in terms of flux density - derivation of expression for the force between two parallel conductors carrying currents and hence definition of ampere -mention of expression for torque on a current loop kept in an uniform magnetic field - construction and theory of moving coil galvanometer - conversion of a pointer galvanometer into an ammeter and voltmeter -problems.

**Electromagnetic Induction:** Statement explanation of Faraday's laws of electromagnetic induction and Lenz's law - derivation of expression for emf induced in a rod moving in a uniform magnetic field -explanation of self induction and mutual induction - mention of expression for energy stored in a coil -explanation of eddy currents - alternating currents - derivation of expression for sinusoidal emf - definition of phase and frequency of ac - mention of the expression for instantaneous, peak, rms, and average values -derivation of expression for current in case of ac applied to a circuit containing (i) pure resistor (ii) inductor (iii) capacitor - derivation of expression for impedance and current in LCR series circuit by phasor diagram method - explanation of resonance - derivation of expression for resonant frequency - brief account of sharpness of resonance and Q-factor - mention of expression for power in ac circuits - power factor and wattless current - qualitative description of choke -basic ideas of magnetic hysteresis - construction and working of transformers - mention of sources of power loss in transformers - ac meters - principle and working of moving iron meter - qualitative explanation of transmission of electrical power - advantages of ac and dc - problems.

## ATOMIC PHYSICS

**Introduction to atomic physics:** Mention of the types of electron emission - description and theory of Dunnington's method of finding  $e/m$  of an electron - explanation of types of spectra: emission and absorption

spectra - brief account of Fraunhofer lines - qualitative explanation of electromagnetic spectrum with emphasis on frequency.

**Photo electric effect:** Explanation of photo electric effect - experiment to study photo electric effect - experimental observations - Einstein's photo electric equation and its explanation - principle and uses of photo cells: (i) photo emissive (ii) photo voltaic (iii) photo conductive cells - problems.

**Dual nature of matter:** Concept of matter waves - arriving at the expression for de Broglie Wave length - principle and working of G.P. Thomson's experiment - principle of Electron Microscope - Scanning Electron Microscope Transmission Electron Microscope and Atomic -Force Microscope.

**Bohr's Atom model:** Bohr's atomic model for Hydrogen like atoms - Bohr's postulates - arriving at the expressions for radius, velocity, energy and wave number - explanation of spectral series of Hydrogen -energy level diagram - explanation of ionization and excitation energy - limitations of Bohr's theory -qualitative explanation of Sommerfeld & Vector atom models - problems.

**Scattering of light:** Explanation of coherent and incoherent scattering - blue of the sky and sea - red at sunrise and sunset - basic concepts and applications of Raman effect.

**Lasers:** Interaction between energy levels and electromagnetic radiation - laser action - population inversion - optical pumping - properties of lasers - construction and working of Ruby laser - mention of applications of lasers - brief account of photonics.

**Nuclear Physics:** Characteristics of nucleus - qualitative explanation of liquid drop model - qualitative explanation of nuclear magnetic resonance (NMR) and its applications in medical diagnostics as MRI -nuclear forces and their characteristics - explanation of Einsteins mass - energy relation - definition of amu and eV - arriving at  $1\text{amu} = 931\text{Mev}$  - examples to show the conversion of mass into energy and vice-versa - mass defect - binding energy - specific binding energy - BE curve - packing fraction.

Nuclear fission with equations - nuclear chain reaction - critical mass - controlled and un-controlled chain reactions - types of nuclear reactors and mention of their principles - disposal of nuclear waste. Nuclear fusion - stellar energy (carbon & proton cycles) - problems.

**Radioactivity:** Laws of radioactivity (i) Soddy's group displacement laws (ii) decay law - derivation of  $N=N_0e^{-\lambda t}$  - explanation of decay constant - derivation of expression for half life - mention of expression for mean life - relation between half and mean life - units of activity: Bequerrel and Curie - Artificial transmutation: Artificial radioactivity -

radio isotopes and mention of their uses - brief account of biological effects of radiations and safety measures - problems.

**Elementary particles:** Basic concepts of leptons and hadrons - qualitative explanation of  $\beta$ -decay - neutrino hypothesis and Quarks.

**Solid state electronics:** Qualitative explanation of Bond theory of solids - classification of conductors, insulators and semiconductors - intrinsic and extrinsic semiconductors - p-type and n-type semiconductors - construction and action of pn-junction - forward and reverse biasing - half wave and full wave rectification - function and application of light emitting diodes - photo diode - laser diode - transistors - npn and pnp transistors - action of transistor - npn transistor as an amplifier in CE mode.

**Digital Electronics:** Logic gates -AND, OR, NOR & NAND symbols and truth table - applications of logic gates (Boolean equations) - half adder and full adder.

**Soft condensed matter physics:** Liquid crystals - classification, thermotropic ( nematic, cholesteric and smectic) and lyotropic liquid crystals - mention of applications of liquid crystals - basic concepts of emulsions, gels & foams.

## **PHYSICS - PART II**

### **Geometrical Optics:**

**Refraction at a plane surface:** Refraction through a parallel sided glass slab - derivation of expressions for lateral shifts and normal shift (object in a denser medium) - total internal reflection and its applications -optical fibers and its application in communication - problems.

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## CHEMISTRY

### STOICHIOMETRY

Equivalent mass of elements - definition, principles involved in the determination of equivalent masses of elements by hydrogen displacement method, oxide method, chloride method and inter conversion method (experimental determination not needed). Numerical problems.

Equivalent masses of acids, bases and salts.

Atomic mass, Molecular mass, vapour density-definitions. Relationship between molecular mass and vapour density. Concept of STP conditions. Gram molar volume. Experimental determination of molecular mass of a volatile substance by Victor Meyer's method. Numerical problems.

Mole concept and Avogadro number, numerical problems involving calculation of: Number of moles when the mass of substance is given, the mass of a substance when number of moles are given and number of particles from the mass of the substance. Numerical problems involving mass-mass, mass-volume relationship in chemical reactions.

Expression of concentration of solutions-ppm, normality, molarity and mole fraction. Principles of volumetric analysis- standard solution, titrations and indicators-acid-base (phenolphthalein and methyl orange) and redox (Diphenylamine). Numerical problems.

## ATOMIC STRUCTURE

Introduction- constituents of atoms, their charge and mass.

Atomic number and atomic mass.

Wave nature of light, Electromagnetic spectrum-emission spectrum of hydrogen-Lyman series, Balmer series, Paschen series, Brackett series and Pfund series. Rydberg's equation. Numerical problems involving calculation of wavelength and wave numbers of lines in the hydrogen spectrum. Atomic model- Bhor's theory, (derivation of equation for energy and radius not required). Explanation of origin of lines in hydrogen spectrum. Limitations of Bhor's theory. Dual nature of electron- distinction between a particle and a wave. de Broglie's theory. Matter-wave equation (to be derived). Heisenberg's uncertainty principle (Qualitative). Quantum numbers - n, l, m and s and their significance and inter relationship. Concept of orbital- shapes of s, p and d orbitals. Pauli's exclusion principle and aufbau principle. Energy level diagram and (n+1) rule. Electronic configuration of elements with atomic numbers from 1 to 54. Hund's rule of maximum multiplicity.

General electronic configurations of s, p and d block elements.

## PERIODIC PROPERTIES

Periodic table with 18 groups to be used.

Atomic radii (Van der Waal and covalent) and ionic radii: Comparison of size of cation and anion with the parent atom, size of isoelectronic ions. Ionization energy, electron affinity, electronegativity- Definition with illustrations. Variation patterns in atomic radius, ionization energy, electron affinity, electronegativity down the group and along the period and their interpretation.

## OXIDATION NUMBER

Oxidation and reduction-Electronic interpretation.

Oxidation number: definition, rules for computing oxidation number. Calculation of the oxidation number of an atom in a compound/ion.

Balancing redox equations using oxidation number method, calculation of equivalent masses of oxidising and reducing agents.

## GASEOUS STATE

GAS LAWS: Boyle's Law, Charles's Law, Avogadro's hypothesis, Dalton's law of partial pressures, Graham's law of diffusion and Gay Lussac's law of combining volumes. Combined gas equation. Kinetic molecular theory of gases-postulates, root mean square velocity, derivation of an equation for the pressure exerted by a gas. Expressions for r.m.s velocity and kinetic energy from the kinetic gas equation. Numerical problems. Ideal and real gases, Ideal gas equation, value of R (SI units). Deviation of real gases from the ideal behaviour. PV-P curves. Causes for the deviation of real gases from ideal behavior. Derivation of Van der Waal's equation and interpretation of PV-P curves

## CHEMICAL KINETICS

Introduction. Commercial importance of rate studies. Order of a reaction. Factors deciding the order of a reaction-relative concentrations of the reactants and mechanism of the reaction. Derivation of equation for the rate constant of a first order reaction. Unit for the rate constant of a first order reaction. Half-life period. Relation between half-life period and order of a reaction. Numerical problems.

Determination of the order of a reaction by the graphical and the Ostwald's isolation method. Zero order, fractional order and pseudo first order reactions with illustrations. Effect of temperature on the rate of a reaction-temperature coefficient of a reaction. Arrhenius interpretation of the energy of activation and temperature dependence of the rate of reaction. Arrhenius equation. Influence of catalyst on energy profile. Numerical problems on energy of activation.

## ORGANIC COMPOUNDS WITH OXYGEN-2, AMINES

### **Phenols:**

Uses of phenol.

Classification: Mono, di and tri-hydric Phenols

Isolation from coal tar and manufacture by Cumene process.

Methods of preparation of phenol from - Sodium benzene sulphonate, Diazonium salts

Chemical properties: Acidity of Phenols - explanation using resonance - Effect of substituents on Acidity (methyl group and nitro group as substituents), Ring substitution reactions - Bromination, Nitration, Friedel-Craft's methylation, Kolbe's reaction, Reimer-Tiemann reaction.

### **Aldehydes and Ketones:**

Uses of methanal, benzaldehyde and acetophenone

Nomenclature

General methods of preparation of aliphatic and aromatic aldehydes and ketones from Alcohols and Calcium salts of carboxylic acids

Common Properties of aldehydes and ketones

- a) Addition reactions with - Hydrogen cyanide, sodium bisulphate
- b) Condensation reactions with - Hydroxylamine, Hydrazine, Phenyl hydrazine, Semicarbazide
- c) Oxidation.

Special reactions of aldehydes: Cannizzaro's reaction - mechanism to be discussed, Aldol condensation, Perkin's reaction, Reducing properties - with Tollen's and Fehling's reagents.

Special reaction of ketones - Clemmensen's reduction

### **Monocarboxylic Acids:**

Uses of methanoic acid and ethanoic acid.

Nomenclature and general methods of preparation of aliphatic acids

From Alcohols, Cyanoalkanes and Grignard reagent

General properties of aliphatic acids: Reactions with - Sodium bicarbonate, alcohols, Ammonia, Phosphorus pentachloride and soda lime

Strength of acids - explanation using resonance.

Effect of substituents (alkyl group and halogen as substituents)

### **Amines:**

Uses of Aniline

Nomenclature Classification - Primary, Secondary, Tertiary - aliphatic and aromatic.

General methods of preparation of primary amines from - Nitro hydrocarbons, Nitriles (cyano hydrocarbons), Amides (Hoffmann's degradation)

General Properties - Alkylation, Nitrous acid, Carbyl amine reaction, Acylation

Tests to distinguish between - Primary, secondary, Tertiary amines - Methylation method.

Interpretation of Relative Basicity of Methylamine, Ammonia and Aniline using inductive effect.

## HYDROCARBONS-2

Stability of Cycloalkanes-Baeyer's Strain theory-interpretation of the properties of Cycloalkanes, strain less ring. Elucidation of the structure of Benzene - Valence Bond Theory and Molecular Orbital Theory. Mechanism of electrophilic substitution reactions of Benzene-halogenations, nitration, sulphonation and Friedel Craft's reaction.

## HALOALKANES

Monohalogen derivatives:

Nomenclature and General methods of preparation from-Alcohols and alkenes.

General properties of monohalogen derivatives: Reduction, with alcoholic KOH, Nucleophilic substitution reactions with alcoholic  $\text{NH}_3$ , KCN, AgCN and aqueous KOH, with Magnesium, Wurtz reaction, Wurtz-Fittig's reaction, Friedal-Craft's reaction

Mechanism of Nucleophilic Substitution reactions-  $\text{SN}_1$  mechanism of Hydrolysis of tertiary butyl bromide and  $\text{SN}_2$  mechanism of Hydrolysis of methyl bromide.

## COORDINATION COMPOUNDS

Co-ordination compound: Definition, complex ion, ligands, types of ligands-mono, bi, tri and polydentate ligands. Co-ordination number, isomerism (ionization linkage, hydrate), Werner's theory, Sidgwick's theory, and E A N rule, Nomenclature of coordination, compounds.

Valence Bond Theory:  $\text{sp}^3$ ,  $\text{dsp}^2$  and  $\text{d}^2\text{sp}^3$  hybridisation taking  $[\text{Ni}(\text{Co})_4]$ ,  $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4$ ,  $\text{K}_4[\text{Fe}(\text{CN})_6]$  respectively as examples.

## CHEMICAL BONDING – 2

Covalent bonding-molecular orbital theory :linear combination of atomic orbitals (Qualitative approach), energy level diagram, rules for filling molecular orbitals, bonding and anti bonding orbitals, bond order, electronic configuration of  $\text{H}_2$ ,  $\text{Li}_2$  and  $\text{O}_2$  Non existence of  $\text{He}_2$  and paramagnetism of  $\text{O}_2$ .

Metallic bond: Electron gas theory (Electron Sea model), definition of metallic bond, correlation of metallic properties with nature of metallic bond using electron gas theory.

## CHEMICAL THERMODYNAMICS-2

Spontaneous and nonSpontaneous process. Criteria for spontaneity-tendency to attain a state of minimum energy and maximum randomness. Entropy-Entropy as a measure of randomness, change in entropy, unit of entropy. Entropy and spontaneity. Second law of thermodynamics. Gibbs' free as a driving force of a reaction Gibbs' equation. Prediction of feasibility of a process in terms of  $\Delta G$  using Gibbs' equation. Standard free energy change and its relation to  $K_p$  (equation to be assumed). Numerical problems.

## SOLID STATE

Crystalline and amorphous solids, differences. Types of crystalline solids - covalent, ionic, molecular and metallic solids with suitable examples. Space lattice, lattice points, unit cell and Co- ordination number.

Types of cubic lattice-simple cubic, body centered cubic, face centered cubic and their coordination numbers. Calculation of number of particles in cubic unit cells. Ionic crystals-ionic radius, radius ratio and its relation to co-ordination number and shape. Structures of NaCl and CsCl crystals.

## ELECTROCHEMISTRY

Electrolytes and non electrolytes. Electrolysis-Faraday's laws of electrolysis. Numerical problems. Arrhenius theory of electrolytic dissociation, Merits and limitations. Specific conductivities and molar conductivity-definitions and units. Strong and weak electrolytes-examples. Factors affecting conductivity.

Acids and Bases: Arrhenius' concept, limitations. Bronsted and Lowry's concept, merits and limitations. Lewis concept, Strengths of Acids and Bases - dissociation constants of weak acids and weak bases. Ostwald's dilution law for a weak electrolytes-(equation to be derived) - expression for hydrogen ion concentration of weak acid and hydroxyl ion concentration of weak base - numerical problems.

Ionic product of water. pH concept and pH scale.  $pK_a$  and  $pK_b$  values-numerical problems. Buffers, Buffer action, mechanism of buffer action in case of acetate buffer and ammonia buffer. Henderson's equation for pH of a buffer(to be derived). Principle involved in the preparation of buffer of required pH-numerical problems. Ionic equilibrium: common ion effect, solubility product, expression for  $K_{sp}$  of sparingly soluble salts of types AB,  $A_2B$  and  $AB_2$ . Relationship between solubility and solubility product of salts of types AB,  $A_2B$  and  $AB_2$ . Applications of common ion effect and solubility product in inorganic qualitative analysis. Numerical problems.

Electrode potential: Definition, factors affecting single electrode potential. Standard electrode potential. Nernst's equation for calculating single electrode potential (to be assumed). Construction of electro-chemical cells-illustration using Daniel cell. Cell free energy change [ $\Delta G^\circ = -nFE^\circ$  (to be assumed)]. Reference electrode: Standard

Hydrogen Electrode-construction, use of SHE for determination of SRP of other single electrodes. Limitations of SHE.

Electrochemical series and its applications. Corrosion as an electrochemical phenomenon, methods of prevention of corrosion.

## ORGANIC CHEMISTRY

Inductive effect, Mesomeric effect and Electromeric effect with illustrations, Conversion of methane to ethane and vice versa and Methanol to ethanol and vice versa

## ISOMERISM-2

Stereo isomerism:geometrical and optical isomerism

Geometrical isomerism-Illustration using 2-butene, maleic acid and fumaric acid as example, Optical Isomerism-Chirality, optical activity-Dextro and Laevo rotation(D and L notations).

## CARBOHYDRATES

Biological importance of carbohydrates, Classification into mono, oligo and poly saccharides. Elucidation of the open chain structure of Glucose. Haworth's structures of Glucose, Fructose, Maltose and Sucrose(elucidation not required).

## OILS AND FATS

Biological importance of oils and fats, Fatty acids-saturated, unsaturated, formation of triglycerides. Generic formula of triglycerides.

Chemical nature of oils and fats-saponification, acid hydrolysis, rancidity refining of oils, hydrogenation of oils, drying oils, iodine value.

## AMINO ACIDS AND PROTEINS

Biological importance of proteins,  $\alpha$ -Aminoacids - General formula

Formulae and unique feature of glycine, alanine, serine, cysteine, aspartic acid, lysine, tyrosine and proline. Zwitter ion, amphiprotic nature, isoelectric point, peptide bond, polypeptides and proteins. Denaturation of proteins

Structural features of Insulin - a natural polypeptide.

## METALLURGY – 2

Physico-chemical concepts involved in the following metallurgical operations -

Desilverisation of lead by Parke's process - Distribution law.

Reduction of metal oxides - Ellingham diagrams - Relative tendency to undergo oxidation in case of elements Fe, Ag, Hg, Al, C, Cr, and Mg.

Blast furnace - metallurgy of iron - Reactions involved and their role, Maintenance of the temperature gradient, Role of each ingredient and Energetics

### INDUSTRIALLY IMPORTANT COMPOUNDS:

Manufacture of Caustic soda by Nelson's cell Method, Ammonia by Haber's process, Sulphuric acid by Contact process and Potassium dichromate from chromite.

Uses of the above compounds.

Chemical properties of Sulphuric acid: Action with metals, Dehydrating nature, Oxidation reactions and Reaction with  $\text{PCl}_5$

Chemical properties of potassium dichromate: With  $\text{KOH}$ , Oxidation reactions, formation of chromyl chloride.

### GROUP 18, NOBEL GASES

Applications of noble gases. Isolation of rare gases from Ramsay and Raleigh's method and separation of individual gases from noble gas mixture (Dewar's charcoal adsorption method). Preparation of  $\text{Pt XeF}_6$  by Neil Bartlett.

### d - BLOCK ELEMENTS (TRANSITION ELEMENTS)

Definition. 3d series: electronic configurations, size, variable oxidation states, colour, magnetic properties, catalytic behaviour, complex formation and their interpretations.

### THEORY OF DILUTE SOLUTIONS

Vant Hoff's theory of dilute Solutions. colligative property. Examples of colligative properties - lowering of vapour pressure, elevation in boiling points, depression in freezing point and osmotic pressure.

Lowering of vapour pressure - Raoult's law (mathematical form to be assumed). Ideal and non ideal solutions (elementary idea) - measurement of relative lowering of vapour pressure - Ostwald and Walker's dynamic method. Determination of molecular mass by lowering of vapour pressure). Numerical problems.

## COLLOIDS

Introduction. Colloidal system and particle size. Types of colloidal systems. Lyophilic and lyophobic sols, examples and differences. Preparation of sols by Bredig's arc method and peptisation. Purification of sols-dialysis and electro dialysis. Properties of sols-Tyndall effect, Brownian movement electrophoresis, origin of charge, coagulation, Hardy and Schulze rule, Protective action of sols. Gold number. Gold number of gelatin and starch. Applications of colloids. Electrical precipitation of smoke, clarification of drinking water and formation of delta.

## BIOLOGY - I

### GENERAL BIOLOGY TOPICS

**Biosystematics:** Introduction - a) Need, history and types of classification (Artificial, Natural and Phylogenetic) b) Species concept, Binomial nomenclature with examples, Rules and advantages of binomial nomenclature. Linnaean hierarchy - Kingdom to species with examples (Cocos nucifera and Homo sapiens). The five - kingdom system of classification in detail - General characters of kingdoms Monera, Protista, Mycota, Metaphyta and Metazoa.

**Cell Biology:** Cell structure: Structure and functions of cell components - cell wall, plasma membrane (fluid mosaic model), endoplasmic reticulum, plastids (brief), mitochondria (brief), Golgi complex, Ribosomes, Lysosomes, Centrosome, vacuole and nucleus - nuclear envelope (nuclear pores and nuclear lamina) nucleoplasm, nucleolus and chromatin. A brief account of ergastic substances (mention about reserve food, secretory and excretory substances with examples). Differences between plant cell and animal cell.

**Chromosomes:** Discovery, shape, size and number of chromosomes, Autosomes and allosomes; Karyotype and idiogram. Chemical composition and function. General structure - Concept of centromere (primary constriction), secondary constriction, satellite, kinetochore, telomere. Types of chromosomes based on the position of centromere. Ultrastructural organization of the eukaryotic chromosome - nucleosome model. Numerical aspects of chromosomes: A brief note on aneuploidy (monosomy and trisomy) and euploidy (haploidy, diploidy and polyploidy).

**Cell Reproduction:** Cell division and types. Concept of cell cycle. Mitotic division and significance. Meiotic division and its significance. Cancer - meaning of cancer, benign and malignant tumours, characters of cancer cells, types of cancer (Carcinoma, Sarcoma, Lymphoma and Leukemia), causes of cancer (physical, chemical and biological carcinogens with examples). Concept of cell senescence and apoptosis (programmed cell death).

## BOTANY TOPICS

**Diversity of life on earth:** Kingdom Monera and other simple living forms - Prions and Viroids: Concept of prions and viroids - definition, discovery, chemical nature with one example of disease each - Creutzfeldt - Jacob disease (CJD) and Potato spindle tuber disease (PSTV).

Viruses: Introduction - living and non-living properties of viruses. Types of viruses - Plant viruses, Animal viruses, Bacterial viruses, DNA viruses and RNA viruses (Only definitions with examples to include the following - Viral disease in plants - Tobacco Mosaic, Cauliflower Mosaic, Potato Mottle, Leaf Mosaic of tomato and Banana Bunchy Top; viral diseases in animals-Rabies, Dog distemper, Viral diseases in man-Japanese Encephalitis, Poliomyelitis, Hepatitis-B, Herpes, AIDS and Conjunctivitis). Structure of T<sub>4</sub> Bacteriophage, multiplication of T<sub>4</sub> phage (Lytic cycle only).

Bacteria: Introduction. Classification of bacteria based on mode of nutrition (Heterotrophic bacteria - parasitic, saprophytic and symbiotic - and Autotrophic bacteria - photosynthetic and chemosynthetic; definition and one example for each group). Ultrastructure of the bacterial cell. Reproduction in bacteria - asexual reproduction by binary fission, endospore formation and sexual mechanism (genetic recombination in bacteria - transduction, transformation and conjugation with details of HFR conjugation only). Importance of bacteria (i) Beneficial aspects - Scavenging, Fermentation, Retting, Antibiotics, Ecological importance, Importance in Genetic engineering and Importance in mineral extraction. (ii) Harmful aspects (iii) Food spoilage and food poisoning. Bacterial diseases - Brief and introductory information on the following diseases: Citrus canker, Anthrax, Cholera, Gastric ulcer, Tuberculosis and Syphilis (details of treatment are not required). (iv) A brief introduction on Archaea and their importance.

Cyanobacteria: Introduction. Structure and reproduction of Nostoc. Differences between bacteria and Cyanobacteria. Importance of Cyanobacteria.

**Kingdom Protista:** General characters. Mentioning the following divisions with suitable examples - Chrysophyta (Diatoms), Euglenophyta (Euglena) and Protozoa. Taxonomic position of Algae with reference to the five-kingdom classification choosing the following examples: Desmids (typical members of Protista) and Spirogyra (A member of metaphyta) are both included in division Chlorophyta (Green Algae). Importance of Algae (in brief).

**Kingdom Mycota** The Fungi: General characters of Fungi. Mentioning divisions with suitable examples. Zygomycota - Rhizopus; Ascomycota - Saccharomyces; Basidiomycota - Agaricus; Duteromycota - Cercospora. Importance of Fungi; A brief account of mushroom culturing (paddy straw mushroom culturing).

**Kingdom Metaphyta:** Bryophyta: General characters of Bryophytes. Mentioning classes with suitable examples - Hepaticopsida - Riccia; Anthocerotopsida - Anthoceros; Bryopsida - Funaria.

Pteridophyta: General characters of Pteridophytes. Mentioning classes with suitable examples - Psilotopsida - Psilotum; Lycopsida - Selaginella; Sphenopsida - Equisetum; Pteropsida - Nephrolepis.

Gymnosperms: General characters of Gymnosperms. Mentioning classes with suitable examples - Cycadopsida - Cycas; Coniferopsida - Pinus; Gnetopsida - Gnetum.

Angiosperms: General characters of angiosperms - Typical dicotyledonous and monocotyledonous plants (Brassica and brass) and difference between dicotyledons and monocotyledons. Study of the Angiosperm flower. Technical terms used in description of flower - Actinomorphic, Zygomorphic, Unisexual, Bisexual, Pedicellate, Sessile, Bracteate, Ebracteate, Homochlamydeous, Heterochlamydeous. Complete flower, Incomplete flower, Epigynous, Hypogynous and Perigynous flowers. The parts of the flower:

a) Accessory whorls:

(i) Concept of perianth

(ii) Calyx - polysepalous and gamosepalous condition with one example each.

(iii) Corolla - Polypetalous and Gamopetalous condition.

(iv) Aestivation - definition and types - Valvate, Imbricate and Twisted types with one example each.

b) Essential whorls:

(i) Androecium - parts of a stamen, adelphy, syngeny, synandry and epipetal. Anther lobes - monothealous and dithealous conditions with one example each.

(ii) Gynoecium - part of gynoecium, concept of carpel, Types of gynoecium - apocarpous and syncarpous gynoecium. Types of gynoecium based on number of carpels - monocarpellary, bicarpellary, tricarpellary and multicarpellary conditions. Nature of ovary of gynoecium with reference to locule - unilocular, bilocular, trilocular and multilocular conditions. Placentation - definition, types - marginal, axile, basal and parietal.

International structure of essential parts: a) T.S of mature anther and structure of the pollen grain (Microsporogenesis not needed) b) Structure of a mature anatropous ovule (Megasporeogenesis not needed).

Pollination in Angiosperms: Definition, self and cross pollination, types (Autogamy, Allogamy, Geitonogamy, Xenogamy, Cleistogamy, Homogamy). Agents (Anemophily, Zoophily - Entomophily - Ornithophily and Hydrophily) with examples. (Pollination mechanisms not needed).

Fertilization in Angiosperms: Definition, a brief account of double fertilization and its significance (Embryogeny not required).

The Angiosperm fruit: Definition, types of fruits - Simple fruits - fleshy fruits (drupe and berry), Dry fruits (capsule, cypsela and cremocarp) and Pome (apple). Aggregate fruits - etaerio of follicles. Multi fruits - Scrosis.

The Angiosperm seed: Concept of seed. A typical dicotyledonous seed (Example: Bean seed). A typical monocotyledonous seed (Example: Maize grain).

**Taxonomy and Economic Botany:** Taxonomy: An outline of classification system of Engler and Prantl.

Distinguishing characters and plants of economic interest of the following families of angiosperms:

Malvaceae - (Hibiscus, Cotton, Lady's finger).

Apocynaceae - (Catheranthus roseus, Rauwolfia serpentina, Plumeria alba and Nerium indicum)

Musaceae - (Musa paradisiaca and Ravenala madagascariensis).

Economic Botany: Introduction. Oil yielding plants - Groundnut and Sunflower. Cereals and millets - Rice and Jowar. Pulses - Pigeon pea and Bengal gram. Medicinal plants - Adathoda vasica, Ephedra gerardiana, Dryopteris, Santalum album, Gymnema sylvestre, Ocimum sanctum, Phyllanthus emblica. Spices - Pepper, cloves and cardamom. Beverages - Coffee, cocoa and tea. (Mentioning scientific names, family, parts used and uses only).

**Elements of plant pathology:** Symptoms, etiology, type and nature of pathogens, and methods of control with reference to the following diseases:

(i) Banana bunchy top

(ii) Tikka disease of groundnut

(iii) Crown gall (of any common dicot plant).

## GENERAL BIOLOGY TOPICS

**Introduction to Biology:** Definition of Biology and its main branches - Botany and Zoology. Scope of Biology. Branches of Biology (definition only). Classical branches - morphology, cytology, histology, anatomy, physiology, developmental biology, biosystematics, genetics, ecology, organic evolution and palaeontology. Interdisciplinary branches - biophysics, biochemistry and biostatistics. Applied branches and career prospects - agriculture, entomology, silviculture, pathology, apiculture, microbiology and bioinformatics. Role of biology in dispelling myths and disbeliefs.

**Biomolecules:** Carbohydrates Definition. Classification - monosaccharides (ribose, deoxyribose, glucose, fructose and galactose), oligosaccharides (maltose, sucrose and lactose) and polysaccharides (starch, glycogen, cellulose, pectin, chitin and agar agar). Biological significance

Proteins: Definition. Classification - simple proteins (albumins, globulins, histones, actin, myosin and keratin), conjugate proteins - Chromoproteins (haemoglobin), glycoproteins (mucin of saliva), phosphoproteins (casein of milk) and lipoproteins (lipovitelline of egg yolk). Biological significance of amino acid and proteins.

Lipids: Definition. Classification - Simple lipids - oils (vegetable oil and oil of animal origin), fats (butter) and waxes (beeswax), Compound lipids - phospholipids (lecithin and cephalin) and sphingolipids (cerebrosides), Related compounds - steroids (estrogen, progesterone and testosterone), sterols (cholesterol) and prostaglandins. Biological significance.

Enzymes: Definition, properties, classification based on functions. Mode of action - induced fit theory of Koshland.

Nucleic acid: Occurrence, basic chemical composition (nucleoside and nucleotide), mention of type (DNA and RNA) and functions (structural details are not required). [\*Note : Details of chemical structure of biomolecules are not required].

**Origin of life and organic evolution:** Origin of life: Introduction. Concept of abiogenesis and biogenesis (experimental evidences not required). A.I. Oparin's Theory of chemical evolution of life (Views of Haldane and Sidney Fox to be mentioned). Stanley Miller's experiment in support of chemical evolution.

Organic evolution: Introduction. Darwin's theory (DDT resistance in mosquitoes and industrial melanism in Peppered moth, to illustrate natural selection to be quoted as examples). Brief account of Mutation theory. NeoDarwinism - Introduction, Darwinian concept vs NeoDarwinian concept (gene pool and gene frequency), Hary - Weinberg law and sources of variations as evolutionary force - sexual reproduction, genetic drift, gene flow, mutation and isolation (reproductive and geographic).

## ZOOLOGY TOPICS

**Diversity of animal life:** Introduction. Outline classification of kingdom Animalia (only the major phyla to be considered). Major animal phyla: Outline classification as treated in 'A Manual of Zoology' Vol. I and Vol. II (1971) by Ekambarantha Ayyar. Non-chordata (animals without backbone) - General characters and classification up to classes [salient features of classes of Invertebrate phyla not to be given] with suitable examples of the following

phyla: Protozoa, Porifera, Coelenterata, Platyhelminthes, Nematoda, Annelida, Arthropoda, Mollusca and Echinodermata. Chordata (Animals with backbone) - Fundamental characters and classification of chordata up to subphyla - Hemichordata, Urochordata, Cephalochordata and Vertebrata with suitable examples. Subphylum Vertebrata - Salient features with examples of (i) Subphylum Pisces: Class Chondrichthyes and Class Osteichthyes); (ii) Superclass Tetrapoda: Amphibia, Reptilia, Aves and Mammalia. Differences between non-chordates and chordates.

**Study of Morphology:** Cockroach - Periplaneta sp. Morphology (Structure of head capsule and compound eye not required). Digestive and nervous systems.

**Animal resources:** Sericulture; Definition. Main aspects - moriculture, rearing of silkworms and reeling.

Brief account of moriculture: definition, methods (row and pit systems) and its importance. Types of silk - mulberry and non-mulberry (Tasar, Eri and Muga). Diseases of mulberry silkworm - Pebrine, Muscardine or Calcino, Flacherie and Grasserie [Listing of diseases and causative organisms only].

**Aquaculture:** Definition. Areas - fin fisheries and shell fisheries. Pisciculture: definition, capture fisheries and culture fisheries. Inland fisheries - procedure. Monoculture, monosex culture and polyculture (composite fish farming) - meaning with examples.

**Dairy:** Definition. Types of indigenous cattle with examples based on utility - draught, milching and dual purpose (Cow breeds - Sindhi, Sahiwal, Amrithmahal, Hallikar, Ongole and Haryana; Buffalo breeds - Murrah, Surti, Mehsana and Nagpuri). Examples of high yielding exotic breeds (Holstein, Red Dane, Jersey and Brown Swiss). Nutritive value of milk. Utility of cattle - biogas, leather, gelatin and organic manure.

**Poultry:** Definition. Types of indigenous fowls with examples based on utility - layers, broilers and dual purpose (Aseel, Chittagong, Ghagus, Basra and Kadaknath). Examples of exotic breeds (White Leghorn, Cornish, Rhode Island Red Plymouth Rock and Newhampshire). Giriraj - origin and salient features.

Nutritive value of egg. Diseases (Respiratory mycoplasmosis, Fowl pox candidiasis, Raniketh and Fowl cholera) - Mentioning of diseases and causative organisms only.

**Vermiculture:** Definition and procedure. Vermicompost - degradation of organic wastes and role of Earthworm in soil fertility.

# BIOLOGY - II

## GENERAL BIOLOGY TOPICS

**Molecular Biology:** Nucleic acids: DNA - Occurrence, DNA as the genetic material (with the experiment of Avery as evidence), chemical composition, structure (Watson - Crick model), Semiconservative method of replication. RNA - Occurrence, chemical composition, brief account of structure and functions of genetic RNA, rRNA, mRNA and tRNA (clover - leaf model).

Gene: The gene, the genetic code and genetic control of protein synthesis - Concept of gene (prokaryotic and eukaryotic), genetic code and its characteristics, genetic control of protein synthesis (transcription and translation) and Lac operon concept.

**Biotechnology:** Introduction: Scope of biotechnology.

Genetic Engineering: Introduction; Tools used in genetic engineering - Vectors (plasmid - pUC18), Enzymes (REN and Ligase), Host cell (E.coli) and Bioreactors.

Recombinant DNA technology and its applications: Insulin synthesis to be used as an example.

A brief account of: DNA fingerprinting, Gene therapy, Human genome project, Monoclonal antibodies.

Improvement of crop plants: Breeding techniques; Tissue culture technique - organ culture example: stem; transgenic plants example: Golden rice.

Improvement of animals: Breeding techniques and stem cell culture, transgenic animals example: Cattle.

Hazards and safeguards of genetic engineering.

## BOTANY TOPICS

**Plant history & anatomy:** Introduction: Definition and general classification of plant tissues.

Meristems: Definition, structure and classification based on position, origin and function (theories an apical organization not required).

Permanent Tissues - Distribution, structure and functions of: Simple tissues: Parenchyma (Chlorenchyma and Aerenchyma), Collenchyma (angular, lacunar & lamellar) and Sclerenchyma - Fibres (Intraxylary and Extraxylary), Sclereids (Macrosclereids, Brachysclereids, Astrosclereids and Osteosclereids).

Complex tissues: Xylem and Phloem. Definition of the terms: Primary and secondary vascular tissues, exarch xylem, endarch xylem, collateral conjoint open and collateral conjoint closed vascular bundles, radial arrangement of vascular tissues. Secondary growth in dicot stem: intrastelar and extrastelar secondary growth. Plant physiology.

**Water relations of plants:** Fundamental concepts: Importance of water to plants. Significance and definitions of the following: Imbibition, Diffusion, Osmosis, Endosmosis, Exosmosis, Plasmolysis, Deplasmolysis, Turgor pressure, Wall pressure, Osmotic pressure. Water potential and its components.

Absorption of water: Structure of root hair. Sources of water for plants (available water and nonavailable water). Region of absorption of water in plants. Entry of water from soil into xylem of root. Active and passive absorption of water (active absorption to show osmotic and non osmotic processes).

Ascent of sap: Definition and evidences to show the involvement of xylem (the Balsam plant experiment). Composition of xylem sap. Transpiration pull theory - merits and demerits.

Loss of water in plants: Transpiration - Definition and types. Structure of a typical stomatal apparatus (dicot example only). Mechanism of stomatal movement - Steward's Starch hydrolysis theory and K<sup>+</sup> pump theory. Factors influencing the rate of transpiration (external). Significance of transpiration. A brief note on antitranspirants.

Guttation: A brief account of guttation - occurrence, causes and structure of hydathode.

Translocation of solutes: Definition and evidences in support of involvement of phloem in the process (Girdling experiment and Tracer method). Composition of phloem sap. Munch's mass flow hypothesis with merits and demerits. Vein loading.

**Bioenergetics:** Introduction: Light as the source of energy and ATP as energy currency.

Photosynthesis Definition. Ultrastructure of the chloroplast. Photosynthetic pigments and their role; composition of photosystems I & II. (Molecular structures and formulae not required). Mechanism - light reaction - cyclic and noncyclic photophosphorylations; Dark reaction (C<sub>3</sub> pathway - Calvin cycle) - (details of regeneration steps not

required);  $C_4$  pathway and CAM (definition and examples only). Influence of external factors on photosynthesis; Blackman's law of limiting factors. Significance of photosynthesis.

Respiration: Definition and types (aerobic and anaerobic). Ultra structure of mitochondrion. Mechanism of aerobic respiration - Glycolysis, Krebs cycle and Terminal oxidation. Anaerobic respiration - Mechanism of fermentation in the presence of yeast and lactic acid bacteria. Role of external factors, respiratory quotient (RQ) and its significance and Pasteur effect.

**Growth and growth regulators in plants:** Growth: Definition, regions of growth, phases of growth and growth curve.

Growth regulators: Definition. Role of the following plant hormones (Details of experiments on discovery of hormones not required):

- i. Auxins.
- ii. Gibberellins.
- iii. Cytokinins.
- iv. Abscissic acid.
- v. Ethylene.

Synthetic growth regulators and their applications (with reference to IAA, IBA, NAA, 2, 4-D, BAP and Ethepon).

## GENERAL BIOLOGY TOPICS

**Genetics:** Mendelian genetics: Mendel and his work. Definitions of the following terms: Allele, Phenotype, Genotype, Homozygous and Heterozygous. Principles of inheritance: Unit characters, dominance, law of segregation (purity of gametes) and law of independent assortment. Monohybrid cross, Dihybrid cross and Test cross.

Deviations from Mendelian laws: Incomplete dominance: Example - Flower colour in *Mirabilis jalapa*.

Multiple allelism: Example - ABO blood groups and their inheritance in man: Blood typing; Rh factor with a note on erythroblastosis foetalis. Sex linked inheritance in man: Example - Inheritance of colourblindness and hypertrichosis in man.

Genetic disorders in man: Chromosomal disorders - Down's syndrome, Klinefelter's syndrome, Turner's syndrome and Cri-du-Chat syndrome. Gene disorders - Sickle cell anemia, haemophilia.

**Biodiversity:** Definition and Types: Ecosystem or habitat diversity, Species diversity and Genetic diversity.

Biodiversity profiles of India and Karnataka: Species diversity, Endemic species, Threatened species and Endangered species.

Benefits of biodiversity: Economic - Traditional crop varieties and lesser known plants and animals of food value, medicinal plants harvested from wild habitat. Ecological/Social - For controlling soil - water regimes and hydrology, for efficient organic residue management and soil fertility management. Ethical - Cultural, Spiritual and Religious belief systems centred around the concept of sacred species, sacred groves and sacred landscapes.

Biodiversity depletion: Anthropocentric causes - urbanization, expansion of agriculture, deforestation, pollution, acidification of soil and water, mining activities, desertification and loss of soil fertility.

Intellectual property rights: Patenting life forms.

Concept of ecosystem sustainability: Conservation of natural resources based on traditional ecological knowledge (TEK): Conservation of Water - rainwater harvesting and watershed management Conservation of soil - Prevention of soil erosion and maintenance of soil fertility: methods of soil conservation. Conservation of forests - Afforestation and maintenance of biosphere reserves. Conservation of wild life - (i) Setting up of national parks, sanctuaries, bioreserves and zoos (ii) Habitat improvement.

Global issues: Concept, causes, effects and control measures of the following: Global warming and greenhouse effect, Ozone layer depletion, Acid rain, Nuclear winter.

## BOTANY TOPICS

**Man in health and diseases:** Concept of Homeostasis - The central Dogma in physiology: Definition. Meaning of internal environment. Factors to be kept constant to achieve homeostasis. An example to illustrate homeostasis - regulation of blood glucose level by liver and pancreas through negative feed back A note on diabetes mellitus.

Body defence and immunity: Introduction. Nonspecific body defences : a) Surface barriers b) Cellular and biochemical defences: phagocytosis, natural killer cells, interferons and inflammatory response. Specific body defences (immunity): Antigen and antibody, role of B and T lymphocytes. Types of immunity: Active (infection and vaccination) and Passive (from mother and immune serum Y-globulins).

Digestion: Gross anatomy of human digestive system (structure of tooth not required). Components of food (concept of balanced diet). Physiology of digestion of carbohydrates, proteins and fats. Disorders: Causes, symptoms and prevention of hyperacidity and ulcer, jaundice and its types and hepatitis.

Circulation: Introduction. Gross anatomy of the human heart. Mechanism of working of heart - cardiac cycle, stroke volume, cardiac out-put, complete double circulation. Origin and conduction of heart beat. Mechanism of blood clotting (Best and Taylor theory). Blood pressure - hypotension and hypertension. Disorders - causes and symptoms of myocardial infarction and cyanosis.

Respiration: Gross anatomy of human respiratory system. Mechanism of respiration:

- (i) Breathing (inspiration and expiration)
- (ii) External respiration (exchange of oxygen and carbon dioxide between alveoli and blood)
- (iii) Internal respiration (exchange of oxygen and carbon dioxide between blood and body cells)
- (iv) Cellular respiration. Disorders: Rhinitis, Asthma and bronchogenic carcinoma. Artificial breathing.

Excretion: Introduction. Gross structure of nephron, Physiology of urine formation. Chemical composition of urine. Disorders: a. Renal failure - acute and chronic b. Renal calculi. Kidney replacement therapy: a brief note on dialysis (haemodialysis and continuous ambulatory peritoneal dialysis) and kidney transplantation.

Nervous system: Components - CNS, PNS & ANS. Human brain - structure (sagittal section only) and functions (functional areas of cerebrum not required). Human spinal cord - structure and functions. Meaning of reflex arc and reflex action. A brief study of the endocrine functions of the pituitary. Disorders: Meaning, causes and symptoms of epilepsy, Parkinson's disease, Alzheimer's disease and Huntington's chorea. Alcoholism and its effects. Narcotic drugs - meaning, listing of types (stimulants, depressants, analgesics and hallucinogens) and their effects. Drug abuse and addiction, Efforts to counter alcoholism and drug menace

**Continuity of life:** Developmental biology (basics of sexual reproduction) - Gametogenesis: Spermatogenesis - formation of spermatids and spermiogenesis (details of spermiogenesis are not required). Ultrastructure of human sperm. Oogenesis. Generalized structure of ovum.

Fertilization - Definition. Types - external and internal. Mechanism. Significance.

Early development of frog - Structure of egg. Cleavage. Blastulation. Gastrulation. Derivatives of primary germ layers.

Human Reproduction: A brief account of Fertilization, Implantation, Placenta. Role of gonadotropins and sex hormones in males and females (meaning of menstrual cycle to be highlighted).

Fertility control - Need for fertility control. Survey of family planning methods: Spacing methods (Barriers, IUDs, Hormonal and Physiological) and Terminal methods (Tubectomy and Vasectomy).

Infertility control - Meaning and causes of infertility in males and females. Remedial methods (Assisted conception methods) - IVF,ET,GIFT and ZIET. (details of GIFT AND ZIFT not required).

Sexually transmitted diseases - Meaning, causative organisms, mode of infection, symptoms and preventive measures of gonorrhoea, syphilis and AIDS.

## MATHEMATICS - I

### ALGEBRA

#### **PARTIAL FRACTIONS**

Rational functions, proper and improper fractions, reduction of improper fractions as a sum of a polynomial and a proper fraction.

Rules of resolving a rational function into partial fractions in which denominator contains

- (i) Linear distinct factors, (ii) Linear repeated factors, (iii) Non repeated non factorizable quadratic factors [problems limited to evaluation of three constants].

#### **LOGARITHMS**

- (i) Definition Of logarithm
- (ii) Indices leading to logarithms and vice versa
- (iii) Laws with proofs:
  - (a)  $\log_a m + \log_a n = \log_a (mn)$
  - (b)  $\log_a m - \log_a n = \log_a (m/n)$
  - (c)  $\log_a m^n = n \log_a m$
  - (d)  $\log_b m = \frac{\log_a m}{\log_a b}$  (change of base rule)
- (iv) Common Logarithm: Characteristic and mantissa; use of logarithmic tables, problems theorem

## MATHEMATICAL INDUCTION

- (i) Recapitulation of the  $n^{\text{th}}$  terms of an AP and a GP which are required to find the general term of the series
- (ii) Principle of mathematical Induction proofs of
  - a.  $\sum n = n(n+1)/2$
  - b.  $\sum n^2 = n(n+1)(2n+1)/6$
  - c.  $\sum n^3 = n^2(n+1)^2/4$By mathematical induction  
Sample problems on mathematical induction

## SUMMATION OF FINITE SERIES

- (i) Summation of series using  $\sum n$ ,  $\sum n^2$ ,  $\sum n^3$
- (ii) Arithmetico-Geometric series
- (iii) Method of differences (when differences of successive terms are in AP)
- (iv) By partial fractions

## THEORY OF EQUATIONS

- (i) FUNDAMENTAL THEOREM OF ALGEBRA: An  $n^{\text{th}}$  degree equation has  $n$  roots (without proof)
- (ii) Solution of the equation  $x^2 + 1 = 0$ . Introducing square roots, cube roots and fourth roots of unity
- (iii) Cubic and biquadratic equations, relations between the roots and the co-efficients. Solutions of cubic and biquadratic equations given certain conditions
- (iv) Concept of synthetic division (without proof) and problems. Solution of equations by finding an integral root between  $-3$  and  $+3$  by inspection and then using synthetic division.  
Irrational and complex roots occur in conjugate pairs (without proof). Problems based on this result in solving cubic and biquadratic equations.

## BINOMIAL THEOREM

Permutation and Combinations:

Recapitulation of  ${}^n P_r$  and  ${}^n C_r$  and proofs of

- (i) general formulae for  ${}^n P_r$  and  ${}^n C_r$
- (ii)  ${}^n C_r = {}^n C_{n-r}$
- (iii)  ${}^n C_{r-1} + {}^n C_r = {}^{n+1} C_r$

(1) Statement and proof of the Binomial theorem for a positive integral index by induction. Problems to find the middle term(s), terms independent of x and term containing a definite power of x.

(2) Binomial co-efficient - Proofs of

(a)  $C_0 + C_1 + C_2 + \dots + C_n = 2^n$

(b)  $C_0 + C_2 + C_4 + \dots = C_1 + C_3 + C_5 + \dots = 2^{n-1}$

## MATHEMATICAL LOGIC

Proposition and truth values, connectives, their truth tables, inverse, converse, contrapositive of a proposition, Tautology and contradiction, Logical Equivalence - standard theorems, Examples from switching circuits, Truth tables, problems.

## GRAPH THEORY

Recapitulation of polyhedra and networks

(i) definition of a graph and related terms like vertices, degree of a vertex, odd vertex, even vertex, edges, loop, multiple edges, u-v walk, trivial walk, closed walk, trail, path, closed path, cycle, even and odd cycles, cut vertex and bridges.

(ii) Types of graphs: Finite graph, multiple graph, simple graph, (p,q) graph, null graph, complete graph, bipartite graph, complete graph, regular graph, complete graph, self complementary graph, subgraph, supergraph, connected graph, Eulerian graph and trees.

(iii) The following theorems:

(1) In a graph with p vertices and q edges ?  $\sum_{i=1}^p \deg v_i = 2q$

(2) In any graph the number of vertices of odd degree is even.

(iv) Definition of connected graph, Eulerian graphs and trees - simple problems.

## ANALYTICAL GEOMETRY

1. Co-ordinate system

(i) Rectangular co-ordinate system in a plane (Cartesian)

(ii) Distance formula, section formula and mid-point formula, centroid of a triangle, area of a triangle - derivations and problems.

(iii) Locus of a point. Problems.

## 2. Straight line

- (i) Straight line: Slope  $m = (\tan\theta)$  of a line, where  $\theta$  is the angle made by the line with the positive x-axis, slope of the line joining any two points, general equation of a line - derivation and problems.
- (ii) Conditions for two lines to be (i) parallel, (ii) perpendicular. Problems.
- (iii) Different forms of the equation of a straight line: (a) slope - point form (b) slope intercept form (c) two points form (d) intercept form and (e) normal form - derivation; Problems.
- (iv) Angle between two lines point of intersection of two lines condition for concurrency of three lines. Length of the perpendicular from the origin and from any point to a line. Equations of the internal and external bisectors of the angle between two lines- Derivations and Problems.

## 3. Pair of straight lines

- (i) Pair of lines, homogenous equations of second degree. General equation of second degree. Derivation of (1) condition for pair of lines (2) conditions for pair of parallel lines, perpendicular lines and distance between the pair of parallel lines. (3) Condition for pair of co-incidence lines and (4) Angle and point of intersection of a pair of lines.

## LIMITS AND CONTINUITY

- (1) Limit of a function - definition and algebra of limits.

- (2) Standard limits (with proofs)

(i)  $\lim_{x \rightarrow a} \frac{x^n - a^n}{x - a} = na^{n-1}$  (n rational)

(ii)  $\lim_{\theta \rightarrow 0} \frac{\sin \theta}{\theta} = 1$  ( $\theta$  in radian) and  $\lim_{\theta \rightarrow 0} \frac{\tan \theta}{\theta} = 1$  ( $\theta$  in radian)

- (3) Statement of limits (without proofs):

(i)  $\lim_{n \rightarrow \infty} \left(1 + \frac{1}{n}\right)^n = e$       (ii)  $\lim_{n \rightarrow \infty} \left(1 + \frac{x}{n}\right)^n = e^x$

(iii)  $\lim_{x \rightarrow 0} (1+x)^{1/x} = e$       (iv)  $\lim_{x \rightarrow 0} \frac{\log(1+x)}{x} = 1$

v)  $\lim_{x \rightarrow 0} \frac{e^x - 1}{x} = 1$       vi)  $\lim_{x \rightarrow 0} \frac{a^x - 1}{x} = \log_e a$

## Problems on limits

- (4) Evaluation of limits which take the form  $\lim_{x \rightarrow 0} \frac{f(x)}{g(x)}$  [0/0 form]  $\lim_{x \rightarrow \infty} \frac{f(x)}{g(x)}$  [8/8 form]

where degree of  $f(x) =$  degree of  $g(x)$ . Problems.

- (5) Continuity: Definitions of left-hand and right-hand limits and continuity. Problems.

## TRIGONOMETRY

### Measurement of Angles and Trigonometric Functions

Radian measure - definition, Proofs of:

- (i) radian is constant
- (ii)  $\pi$  radians =  $180^\circ$
- (iii)  $s = r\theta$  where  $\theta$  is in radians
- (iv) Area of the sector of a circle is given by  $A = \frac{1}{2} r^2\theta$  where  $\theta$  is in radians. Problems

Trigonometric functions - definition, trigonometric ratios of an acute angle, Trigonometric identities (with proofs) - Problems. Trigonometric functions of standard angles. Problems. Heights and distances - angle of elevation, angle of depression, Problems. Trigonometric functions of allied angles, compound angles, multiple angles, submultiple angles and Transformation formulae (with proofs). Problems. Graphs of  $\sin x$ ,  $\cos x$  and  $\tan x$ .

### Relations between sides and angles of a triangle

Sine rule, Cosine rule, Tangent rule, Half-angle formulae, Area of a triangle, projection rule (with proofs). Problems. Solution of triangles given (i) three sides, (ii) two sides and the included angle, (iii) two angles and a side, (iv) two sides and the angle opposite to one of these sides. Problems.

## MATHEMATICS - II

### ALGEBRA

#### ELEMENTS OF NUMBER THEORY

- (i) Divisibility - Definition and properties of divisibility; statement of division algorithm.
- (ii) Greatest common divisor (GCD) of any two integers using Euclid's algorithm to find the GCD of any two integers. To express the GCD of two integers  $a$  and  $b$  as  $ax + by$  for integers  $x$  and  $y$ . Problems.
- (iii) Relatively prime numbers, prime numbers and composite numbers, the number of positive divisors of a number and sum of all positive divisors of a number - statements of the formulae without proofs. Problems.
- (iv) Proofs of the following properties:
  - (1) the smallest divisor ( $>1$ ) of an integer ( $>1$ ) is a prime number
  - (2) there are infinitely many primes

- (3) if  $c$  and  $a$  are relatively prime and  $c \mid ab$  then  $c \mid b$
- (4) if  $p$  is prime and  $p \mid ab$  then  $p \mid a$  or  $p \mid b$
- (5) if there exist integers  $x$  and  $y$  such that  $ax+by=1$  then  $(a,b)=1$
- (6) if  $(a,b)=1$ ,  $(a,c)=1$  then  $(a,bc)=1$
- (7) if  $p$  is prime and  $a$  is any integer then either  $(p,a)=1$  or  $p \mid a$
- (8) the smallest positive divisor of a composite number  $a$  does not exceed  $\sqrt{a}$

Congruence modulo  $m$  - definition, proofs of the following properties:

- (1) " $\equiv \pmod{m}$ " is an equivalence relation
- (2)  $a \equiv b \pmod{m} \Rightarrow a \pm x \equiv b \pm x \pmod{m}$  and  $ax \equiv bx \pmod{m}$
- (3) If  $c$  is relatively prime to  $m$  and  $ca \equiv cb \pmod{m}$  then  $a \equiv b \pmod{m}$  - cancellation law
- (4) If  $a \equiv b \pmod{m}$  - and  $n$  is a positive divisor of  $m$  then  $a \equiv b \pmod{n}$
- (5)  $a \equiv b \pmod{m} \Rightarrow a$  and  $b$  leave the same remainder when divided by  $m$

Conditions for the existence of the solution of linear congruence  $ax \equiv b \pmod{m}$  (statement only), Problems on finding the solution of  $ax \equiv b \pmod{m}$

## GROUP THEORY

Groups - (i) Binary operation, Algebraic structures. Definition of semigroup, group, Abelian group - examples from real and complex numbers, Finite and infinite groups, order of a group, composition tables, Modular systems, modular groups, group of matrices - problems.

(ii) Square roots, cube roots and fourth roots of unity from abelian groups w.r.t. multiplication (with proof).

(iii) Proofs of the following properties:

- (i) Identity of a group is unique
- (ii) The inverse of an element of a group is unique
- (iii)  $(a^{-1})^{-1} = a$ ,  $\forall a \in G$  where  $G$  is a group
- (iv)  $(a * b)^{-1} = b^{-1} * a^{-1}$  in a group
- (v) Left and right cancellation laws
- (vi) Solutions of  $a * x = b$  and  $y * a = b$  exist and are unique in a group
- (iv) Subgroups, proofs of necessary and sufficient conditions for a subgroup.

- (a) A non-empty subset  $H$  of a group  $G$  is a subgroup of  $G$  iff (i)  $\forall a, b \in H, a * b \in H$  and (ii) For each  $a \in H, a^{-1} \in H$
- (b) A non-empty subset  $H$  of a group  $G$  is a subgroup of  $G$  iff  $a, b \in H, a * b^{-1} \in H$ . Problems.

## VECTORS

- (i) Definition of vector as a directed line segment, magnitude and direction of a vector, equal vectors, unit vector, position vector of point, problems.
- (ii) Two and three-dimensional vectors as ordered pairs and ordered triplets respectively of real numbers, components of a vector, addition, subtraction, multiplication of a vector by a scalar, problems.
- (iii) Position vector of the point dividing a given line segment in a given ratio.
- (iv) Scalar (dot) product and vector (cross) product of two vectors.
- (v) Section formula, Mid-point formula and centroid.
- (vi) Direction cosines, direction ratios, proof of  $\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$  and problems.
- (vii) Application of dot and cross products to the area of a parallelogram, area of a triangle, orthogonal vectors and projection of one vector on another vector, problems.
- (viii) Scalar triple product, vector triple product, volume of a parallelepiped; conditions for the coplanarity of 3 vectors and coplanarity of 4 points.
- (ix) Proofs of the following results by the vector method:
- diagonals of parallelogram bisect each other
  - angle in a semicircle is a right angle
  - medians of a triangle are concurrent; problems
  - sine, cosine and projection rules
  - proofs of 1.  $\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$   
2.  $\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$

## MATRICES AND DETERMINANTS

- (i) Recapitulation of types of matrices; problems
- (ii) Determinant of square matrix, defined as mappings  $f: M(2, \mathbb{R}) \rightarrow \mathbb{R}$  and  $f: M(3, \mathbb{R}) \rightarrow \mathbb{R}$ . Properties of determinants including  $f(AB) = f(A) f(B)$ , Problems.
- (iii) Minor and cofactor of an element of a square matrix, adjoint, singular and non-singular matrices, inverse of a matrix. Proof of  $A(\text{Adj } A) = (\text{Adj } A)A = |A| I$  and hence the formula for  $A^{-1}$ . Problems.
- (iv) Solution of a system of linear equations in two and three variables by (1) Matrix method, (2) Cramer's rule. Problems.

- (v) Characteristic equation and characteristic roots of a square matrix. Cayley-Hamilton theorem |statement only|. Verification of Cayley-Hamilton theorem for square matrices of order 2 only. Finding  $A^{-1}$  by Cayley-Hamilton theorem. Problems.

## ANALYTICAL GEOMETRY

### CIRCLES

(i) Definition, equation of a circle with centre (0,0) and radius r and with centre (h,k) and radius r. Equation of a circle with  $(x_1, y_1)$  and  $(x_2, y_2)$  as the ends of a diameter, general equation of a circle, its centre and radius - derivations of all these, problems.

(ii) Equation of the tangent to a circle - derivation; problems. Condition for a line  $y=mx+c$  to be the tangent to the circle  $x^2+y^2 = r^2$  - derivation, point of contact and problems.

(iii) Length of the tangent from an external point to a circle - derivation, problems

(iv) Power of a point, radical axis of two circles, Condition for a point to be inside or outside or on a circle - derivation and problems. Proof of the result "the radical axis of two circles is straight line perpendicular to the line joining their centres". Problems.

(v) Radical centre of a system of three circles - derivation, Problems.

(vi) Orthogonal circles - derivation of the condition. Problems

### CONIC SECTIONS (ANALYTICAL GEOMETRY)

Definition of a conic

#### 1. Parabola

Equation of parabola using the focus directrix property (standard equation of parabola) in the form  $y^2 = 4ax$ ; other forms of parabola (without derivation), equation of parabola in the parametric form; the latus rectum, ends and length of latus rectum. Equation of the tangent and normal to the parabola  $y^2 = 4ax$  at a point (both in the Cartesian form and the parametric form) (1) derivation of the condition for the line  $y=mx+c$  to be a tangent to the parabola,  $y^2=4ax$  and the point of contact. (2) The tangents drawn at the ends of a focal chord of a parabola intersect at right angles on the directrix - derivation, problems.

#### 2. Ellipse

Equation of ellipse using focus, directrix and eccentricity - standard equation of ellipse in the form  $x^2/a^2 + y^2/b^2 = 1$  ( $a > b$ ) and other forms of ellipse (without derivations). Equation of ellipse in the parametric form and auxiliary circle. Latus rectum: ends and the length of latus rectum. Equation of the tangent and the normal to the ellipse at a point (both in the cartesian form and the parametric form)

Derivations of the following:

- (1) Condition for the line  $y=mx+c$  to be a tangrent to the ellipse  $x^2/a^2 + y^2/b^2 = 1$  at  $(x_1, y_1)$  and finding the point of contact
- (2) Sum of the focal distances of any point on the ellipse is equal to the major axis
- (3) The locus of the point of intersection of perpendicular tangents to an ellipse is a circle (director circle)

### 3 Hyperbola

Equation of hyperbola using focus, directrix and eccentricity - standard equation hyperbola in the form  $x^2/a^2 - y^2/b^2 = 1$ . Conjugate hyperbola  $x^2/a^2 - y^2/b^2 = -1$  and other forms of hyperbola (without derivations). Equation of hyperbola in the parametric form and auxiliary circle. The latus rectum; ends and the length of latus rectum. Equations of the tangent and the normal to the hyperbola  $x^2/a^2 - y^2/b^2 = 1$  at a point (both in the Cartesian form and the parametric form). Derivations of the following results:

- (1) Condition for the line  $y=mx+c$  to be tangent to the hyperbola  $x^2/a^2 - y^2/b^2 = 1$  and the point of contact.
- (2) Differnce of the focal distances of any point on a hyperbola is equal to its transverse axis.
- (3) The locus of the point of intersection of perpendicular tangents to a hyperbola is a circle (director circle)
- (4) Asymptotes of the hyperbola  $x^2/a^2 - y^2/b^2 = 1$
- (5) Rectangular hyperbola
- (6) If  $e_1$  and  $e_2$  are eccentricities of a hyperbola and its conjugate then  $1/e_1^2 + 1/e_2^2 = 1$

## TRIGONOMETRY

### COMPLEX NUMBERS

- (i) Definition of a complex number as an ordered pair, real and imaginary parts, modulus and amplitude of a complex number, equality of complex numbers, algebra of complex numbers, polar form of a complex number. Argand diagram, Exponential form of a complex number. Problems.
- (ii) De Moivre's theorem - statement and proof, method of finding square roots, cube roots and fourth roots of a complex number and their representation in the Argand diagram. Problems.

### DIFFERENTIATION

- (i) Differentiability, derivative of function from first principles, Derivatives of sum and difference of functions, product of a constant and a function, constant, product of two functions, quotient of two functions from first principles. Derivatives of  $X^n$ ,  $e^x$ ,  $a^x$ ,  $\sin x$ ,  $\cos x$ ,  $\tan x$ ,  $\operatorname{cosec} x$ ,  $\sec x$ ,  $\cot x$ ,  $\log x$  from first principles, problems.

- (ii) Derivatives of inverse trigonometric functions, hyperbolic and inverse hyperbolic functions.
- (iii) Differentiation of composite functions - chain rule, problems.
- (iv) Differentiation of inverse trigonometric functions by substitution, problems.
- (v) Differentiation of implicit functions, parametric functions, a function w.r.t another function, logarithmic differentiation, problems.
- (vi) Successive differentiation - problems upto second derivatives.

## APPLICATIONS OF DERIVATIVES

- (i) Geometrical meaning of  $dy/dx$ , equations of tangent and normal, angle between two curves. Problems.
- (ii) Subtangent and subnormal. Problems.
- (iii) Derivative as the rate measurer. Problems.
- (iv) Maxima and minima of a function of a single variable - second derivative test. Problems.

## INVERSE TRIGONOMETRIC FUNCTIONS

- (i) Definition of inverse trigonometric functions, their domain and range. Derivations of standard formulae. Problems.
- (ii) Solutions of inverse trigonometric equations. Problems.

## GENERAL SOLUTIONS OF TRIGONOMETRIC EQUATIONS

General solutions of  $\sin x = k$ ,  $\cos x = k$ , ( $-1 = k = 1$ ),  $\tan x = k$ ,  $a \cos x + b \sin x = c$  - derivations. Problems.

## INTEGRATION

(i) Statement of the fundamental theorem of integral calculus (without proof). Integration as the reverse process of differentiation. Standard formulae. Methods of integration, (1) substitution, (2) partial fractions, (3) integration by parts. Problems.

(4) Problems on integrals of:

$$1/(a+b\cos x); 1/(a+b\sin x); 1/(a\cos x+b\sin x+c); 1/a\sin 2x+b\cos 2x+c; [f(x)]^n f'(x);$$

$$f'(x)/f(x); 1/\sqrt{a^2-x^2}; 1/\sqrt{x^2-a^2}; 1/\sqrt{a^2+x^2}; 1/x\sqrt{x^2\pm a^2}; 1/(x^2-a^2);$$

$$\sqrt{a^2\pm x^2}; \sqrt{x^2-a^2}; px+q/(ax^2+bx+c); px+q/\sqrt{ax^2+bx+c}; p\cos x+q\sin x/(a\cos x+b\sin x); e^x[f(x)+f'(x)]$$

## DEFINITE INTEGRALS

- (i) Evaluation of definite integrals, properties of definite integrals, problems.
- (ii) Application of definite integrals - Area under a curve, area enclosed between two curves using definite integrals, standard areas like those of circle, ellipse. Problems.

## **DIFFERENTIAL EQUATIONS**

Definitions of order and degree of a differential equation, Formation of a first order differential equation, Problems. Solution of first order differential equations by the method of separation of variables, equations reducible to the variable separable form. General solution and particular solution. Problems.

## **GENERAL ENGLISH**

Broadly, this paper includes questions on general English like spotting of errors, sentence improvement, vocabulary etc.