

ITEM NO.19 IN PROGRAMME NO.15/2009

CATEGORY NO.54/2007

DETAILED TOPICS

Part I - PHYSICS

1. Laws of Motion

Inertia, Newton's first Law of Motion; Momentum and Newton's Second Law of Motion; Impulse; Newton's Third Law of Motion.

2. Kinematics

Frame of reference. Motion in a straight line: Position-time graph, Speed and Velocity. Uniform and Non-Uniform Motion, Average Speed and instantaneous velocity. Uniformly accelerated motion, Velocity-time and position — time graphs, relations for uniformly accelerated motion.

3. Work, Energy and Power

Scalar product of Vectors. Work done by a constant force and a variable force; Kinetic Energy, Work-Energy theorem, Power. Notion of Potential Energy, Conservative Forces; Conservation of Mechanical Energy, Nonconservative forces.

4. Properties of Bulk Matter

Elastic behaviour, Stress-strain relationship, Hooke's Law, Young's modulus, bulk modulus, shear, modulus of rigidity. Pressure due to a fluid column; Pascal's Law and its applications, Effect of gravity on fluid pressure. Viscosity, Stokes' law, terminal velocity, Reynold's Number, streamline and turbulent flow. Bernoulli's theorem and its applications. Surface energy and Surface tension, angle of contact, application of surface tension ideas to drops, bubbles and capillary rise. Heat, temperature, thermal expansion; specific heat capacity — Calorimetry; Change of state — latent heat. Heat Transfer — Conduction, Convection and radiation, thermal conductivity, Newton's law of cooling.

5. Physical Chemistry of Milk

Physico Chemical properties of milk. Density, Specific gravity, Surface Tension, Viscosity Aqueous solution of electrolytes and non electrolytes. Oxidation Reduction Redox potential, Colloidal State, Nuclear Chemistry, Molecular Spectroscopy.

6. Thermodynamics and Heat Transfer

Basic concepts, Processes, Cycle, Energy. Thermal equilibrium and definition of temperature (Zeroth Law of Thermodynamics). Heat, work and internal energy. First Law of Thermodynamics internal energy, enthalpy.

Second law of thermodynamics: Carnot cycles, entropy, Reversible and irreversible processes. Heat Engines and refrigerators. Air cycles: Otto, Diesel, and Dual cycles. IC engines: Two stroke and four stroke cycles. Basic Heat Transfer process, thermal conductivity, Convection, Radiation, Heat Exchangers, Different types of heat exchangers in dairy and food industry.

7. Electromagnetic Induction and Alternating Currents

Electromagnetic Induction; Faraday's Law, Induced EMF and current; Lenz's Law, Eddy currents. Self and mutual inductance. Need for displacement current. Alternating currents, peak and rms value of alternating current/voltage; reactance and impedance; LC Oscillations (qualitative treatment only), LCR series circuit, resonance; Power in AC circuits, wattless current. AC generator and transformer.

8. Electrical Engineering and Instrumentation

Transformers, Alternators, Induction motors, DC Machines, Electric power economics

Part II - CHEMISTRY

1. Structure of Atom, Chemical Bonding and Molecular Structure

Discovery of electron, proton and neutron; atomic number, isotopes and isobars.

Valence electrons, ionic bond, covalent bond, bond parameters, Lewis structure, polar character of covalent bond, covalent character of ionic bond, valence bond theory, resonance, geometry of covalent molecules, VSEPR theory.

2. Physical and Chemical Equilibrium

Equilibrium in physical and chemical processes, 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, concept of pH.

3. Solutions

Types of solutions, Colligative properties: relative lowering of vapour pressure, elevation of boiling point, depression of freezing point, osmotic pressure, determination of molecular masses using colligative properties, abnormal molecular mass.

4. 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.

5. Organic Chemistry

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.

6. Alcohols, Aldehydes, Ketones, Carboxylic acids and Amines

Alcohols: Important properties of mono, di and trihydric alcohols (glycol and glycerol), Nomenclature, physical and chemical properties, identification of primary, secondary and tertiary alcohols, mechanism of dehydration, uses, some important compounds — methanol and ethanol.

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

Carboxylic acids: Nomenclature, acidic nature, methods of preparation, physical and chemical properties, uses.

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 of context)

7. Biomolecules

Carbohydrates: Classification (aldoses and ketoses), monosaccharides (glucose and fructose), oligosaccharides (sucrose, lactose, maltose), polysaccharides (starch, cellulose, glycogen), importance. Intermediary metabolism of carbohydrates, lipids and proteins.

Proteins: Elementary idea of alpha amino acids, peptide bond, poly peptides, proteins, primary, secondary, tertiary and quaternary structure (qualitative idea only), denaturation of proteins, enzymes.

Nucleic acids: DNA and RNA — Structure and function, Definition and composition

Fatty acids and Lipids: Definition and classification, important reactions of fatty acids, structure and properties of neutral lipids, phospholipids and cholesterol.

Vitamins: Classifications and functions.

8. Chemistry in Everyday life

Chemicals in medicine — analgesics, tranquilizers, antiseptics, disinfectants, antimicrobials, antifertility drugs, antibiotics, antacids, antihistamines.

Chemicals in food — preservatives, artificial sweetening agents. Cleansing agents — soaps and detergents, cleansing action.

9. Chemistry of Milk

Elementary knowledge of milk synthesis in the mammary gland, constituents and gross composition of milk, factors affecting composition, preservatives, adulterants and neutralizers in milk and their detection. Nomenclature and classification of milk proteins, milk enzymes, milk carbohydrates, milk salts. Soft and hard water, temporary and permanent hardness of water, softening of water.

10. Environmental Chemistry

Air, water and soil pollution, chemical reactions in atmosphere, smogs, major atmospheric pollutants, acid rain, ozone and its reactions, effects of depletion of ozone layer, green house effect and global warming. Pollution due to industrial wastes, green chemistry as an alternative tool for reducing pollution, strategy for control of environmental pollution.

Part III - BIOLOGY

1. Structural Organization in Animals and Plants

Tissues in animals and plants. Morphology, anatomy and functions of different parts of flowering plants: Root, stem, leaf, inflorescence, flower, fruit and seed.

2. Human Physiology

Digestion and Absorption
Breathing and respiration
Body fluids and circulation
Excretory products and elimination
Locomotion and movement.
Control and Co-ordination.

3. Sexual Reproduction

Pollination and fertilization in flowering plants.

Development of seeds and fruits.

Human Reproduction: Reproductive system in male and female, menstrual cycle.

Production of gametes, fertilization, implantation, embryo development, pregnancy and parturation.

4. Cells and Enzymes

Cell: Cell wall, Cell membrane and Cell organelles (plastids, mitochondria, endoplasmic reticulum, Golgi bodies / dictyosomes, ribosomes, lysosomes, vacuoles, centrioles) and nuclear organization. Mitosis, meiosis, cell cycle. Basic chemical constituents of living bodies. Structure and functions of carbohydrates, proteins, lipids and nucleic acids.

Enzymes: Types, properties and function.

5. Genetics and Evolution

Mendelian inheritance. Chromosome theory of inheritance, deviations from Mendelian ratio (gene interaction — Incomplete dominance, co-dominance, complementary genes, multiple alleles). Sex determination in human beings: XX, XY. Linkage and crossing over. Inheritance pattern of haemophilia and blood groups in human beings.

DNA : replication, transcription, translation
 Gene expression and regulation.
 Genome and Human Genome Project.
 DNA Fingerprinting.
 Evolution: Theories and evidences.

6. Biology and Human Welfare

Animal Husbandry. Basic concepts of immunology, vaccines. Pathogens, Parasites, Plant breeding, Tissue culture, Food production.

Microbes in household food processing, industrial production, Sewage treatment and energy generation.

Microbiology of milk and milk products.

7. Ecology and Environment

Ecosystems: Components, types and energy flow. Species, Population and Community. Ecological adaptations.

Centres of diversity and conservation of biodiversity, National Parks and Sanctuaries. Environmental Issues.

Part IV - MATHEMATICS

1. Sets and Functions

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

2. 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.

3. Algebra

i. Principle of Mathematical Induction

ii. Quadratic Equations

iii. Linear Inequalities

iv. Permutations and Combinations:

Fundamental principle of counting. Factorial n Permutations and Combinations. Derivation of formulae and their connections, simple applications.

v. 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.

vi. Sequence and Series

Sequence and Series. Arithmetic Progression (A.P.), Arithmetic Mean (A.M.), Geometric Progression (G.P.), general term of a GP, sum of n terms of a G.P., geometric mean (G.M.), relation between A.M. and G.M. Sum to n terms of the special series.

vii. Matrices

Concept, notation, order, equality, types of matrices, zero matrix, transpose of a matrix, symmetric and skew symmetric matrices. Addition, multiplication and scalar multiplication of matrices, simple properties of addition, multiplication and scalar multiplication. Non commutativity 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).

viii. Determinants

Determinant of a square matrix (up to 3×3 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 equations by examples, solving system of linear equations in two or three variables (having unique solution) using inverse of a matrix.

4. Statistics and Probability

i. Statistics

Measure of dispersion; mean deviation, variance and standard deviation of ungrouped / grouped data. Analysis of frequency distributions with equal means but different variances.

ii. 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 the theories of earlier classes. Probability of an event, probability of 'not', 'and' & 'or' events.

5. Calculus

i. Continuity and Differentiability

Continuity and Differentiability, derivative of composite functions, chain rule, derivatives of inverse trigonometric functions, derivative of implicit function. Concept of exponential and logarithmic functions and their derivatives. Logarithmic differentiation. Derivative of functions expressed in parametric forms. Second order derivatives. Rolley's theorem.

ii. Linear Programming

Introduction, related terminology such as constraints, objective function, optimization, different types of linear programming, (L.P.) problems, mathematical formulation of L.P. problems, graphical method for solution of problems in two variables, feasible and infeasible regions, feasible and infeasible solutions, optimal feasible solutions (upto three non-trivial constraints).

iii. Probability

Multiplication theorem on probability. Conditional probability, independent events, total probability, Baye's theorem. Random variable and its probability distribution, mean and variance of haphazard variable. Repeated independent (Bernoulli) trials and Binomial distribution.

NOTE: - It may be noted that apart from the topics detailed above, questions from other topics prescribed for the educational qualification of the post may also appear in the question paper. There is no undertaking that all the topics above may be covered in the question paper.