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PHYSICS

1. Laws of Motion & Work, Energy and Power

Law of conservation of linear momentum and its applications. Static and kinetic friction - laws of friction - rolling friction - lubrication.

Work done by a constant force and a variable force; kinetic energy - work-energy theorem - power.

Conservative forces: conservation of mechanical energy (kinetic and potential energies) - non-conservative
forces: motion in a vertical circle - elastic and inelastic collisions in one and two dimensions.

2. Properties of Matter

Elastic behaviour - Stress-strain relationship - Hooke's law - Young's modulus - bulk modulus - shear modulus of rigidity - Poisson's ratio - elastic energy. Viscosity - Stokes' law - terminal velocity - streamline and turbulent flow - critical velocity. Bernoulli's theorem and its applications.

Heat - temperature - thermal expansion: thermal expansion of solids - specific heat capacity: C_p, C_v -
latent heat capacity. Qualitative ideas of Blackbody radiation: Wein's displacement Law - Stefan's law.

3. Electrostatics

Charges and their conservation; Coulomb's law-forces between two point electric charges - Forces between multiple electric charges-superposition principle. Electric field – electric field due to a point charge, electric field lines; electric dipole, electric field intensity due to a dipole - behaviour of a dipole in a uniform electric field. Electric potential - potential difference-electric potential due to a point charge and dipole-equipotential surfaces – electrical potential energy of a system of two point charges.

Electric flux-Gauss's theorem and its applications. Electrostatic induction-capacitor and capacitance – dielectric and electric polarisation – parallel plate capacitor with and without dielectric medium – applications of capacitor – energy stored in a capacitor - Capacitors in series and in parallel – action of points – Van de Graaff generator.

4. Current Electricity

Electric Current – flow of charges in a metallic conductor – drift velocity and mobility and their relation with electric current. Ohm's law, electrical resistance - V-I characteristics – electrical resistivity and conductivity-classification of materials in terms of conductivity – Carbon resistors – colour code for carbon resistors - combination of resistors – series and parallel – temperature dependence of resistance – internal resistance of a cell – potential difference and emf of a cell - combinations of cells in series and in parallel.

Kirchoff's law – Wheatstone's Bridge and its application for temperature coefficient of resistance measurement - Metrebridge - special case of Wheatstone bridge - Potentiometer principle - comparing the emf of two cells.

5. Magnetic Effects of Electric Current

Magnetic effect of electric current – Concept of magnetic field - Oersted's experiment – Biot-Savart law-Magnetic field due to an infinitely long current carrying straight wire and circular coil – Tangent galvanometer – construction and working – Bar magnet as an equivalent solenoid – magnetic field lines.

Ampere's circuital law and its application. Force on a moving charge in uniform magnetic field and electric field – cyclotron – Force on current carrying conductor in a uniform magnetic field – Forces between two parallel current carrying conductors - definition of ampere.Torque experienced by a current loop in a uniform magnetic field - moving coil galvanometer – conversion to ammeter and voltmeter – current loop as a magnetic dipole and its magnetic dipole moment - Magnetic dipole moment of a revolving electron.

6. Electromagnetic Induction and Alternating Current

Electromagnetic induction - Faraday's law - induced emf and current - Lenz's law. Self induction - Mutual induction - self inductance of a long solenoid - mutual inductance of two long solenoids. Methods of inducing emf - (i) by changing magnetic induction (ii) by changing area enclosed by the coil and (iii) by changing the orientation of the coil (quantitative treatment).

AC generator - commercial generator. (Single phase, three phase). Eddy current - applications - transformer - long distance transmission. Alternating current - measurement of AC - AC circuit with resistance - AC circuit with inductor - AC circuit with capacitor - LCR series circuit - Resonance and Q - factor - power in AC circuits.

7. Optics

Reflection of light, spherical mirrors, mirror formula. Refraction of light, total internal reflection and its applications, optical fibers, refraction at spherical surfaces, lenses, thin lens formula, lens maker's formula. Magnification, power of a lens, combination of thin lenses in contact, combination of a lens and a mirror. Refraction and dispersion of light through a prism. Scattering of light-blue colour of sky and reddish appearances of the sun at sunrise and sunset.

Wavefront and Huygens's principle - Reflection, total internal reflection and refraction of plane wave at a plane surface using wavefronts. Interference - Young's double slit experiment and expression for fringe width - coherent source - interference of light - Formation of colours in thin films - Newton's rings. Diffraction - differences between interference and diffraction of light- diffraction grating. Polarisation of light waves - polarisation by reflection - Brewster's law - double refraction - nicol prism - uses of plane polarised light and Polaroids - rotatory polarisation - polarimeter.

8. Dual Nature of Radiation and Atomic Physics

Electromagnetic waves and their characteristics - Electromagnetic spectrum - Photoelectric effect - Light waves and photons - Einstein's photoelectric equation - laws of photoelectric emission - particle nature of light - photo cells and their applications.

Atomic structure – discovery of the electron – specific charge (Thomson's method) and charge of the electron (Millikan's oil drop method) – alpha scattering – Rutherford's atom model.

9. Nuclear Physics

Nuclear properties - nuclear radii, masses, binding energy, density, charge - isotopes, isobars and isotones - nuclear mass defect - binding energy - stability of nuclei - Bainbridge mass spectrometer.

Nature of nuclear forces - Neutron - discovery - properties - artificial transmutation - particle accelerator. Radioactivity - alpha, beta and gamma radiations and their properties - Radioactive decay law - half life - mean life - artificial radioactivity - radio isotopes - effects and uses - Geiger - Muller counter. Radio carbon dating. Nuclear fission - chain reaction - atom bomb - nuclear reactor - nuclear fusion - Hydrogen bomb - cosmic rays - elementary particles.

10. Semiconductor Devices and their Applications

Semiconductor basics - energy band in solids: difference between metals, insulators and semiconductors - semiconductor doping - Intrinsic and Extrinsic semiconductors. Formation of P-N Junction - Barrier potential and depletion layer-P-N Junction diode - Forward and reverse bias characteristics - diode as a rectifier - Zener diode-Zener diode as a voltage regulator - LED. Junction transistors - characteristics - transistor as a switch - transistor as an amplifier - transistor as an oscillator.

Logic gates - NOT, OR, AND, EXOR using discrete components - NAND and NOR gates as universal gates - De Morgan's theorem - Laws and theorems of Boolean algebra.

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CHEMISTRY

1. Atomic Structure

Bohr's atomic model-Sommerfeld's extension of atomic structure; Electronic configuration and Quantum numbers; Shapes of s,p,d,f orbitals - Pauli's exclusion principle - Hund's Rule of maximum multiplicity- Aufbau principle. Emission and absorption spectra, line and band spectra; Hydrogen spectrum – Lyman, Balmer, Paschen, Brackett and Pfund series; deBroglie's theory; Heisenberg's uncertainty principle – wave nature of electron – Schrodinger wave equation (No derivation). Eigen values and eigen functions. Hybridization of atomic orbitals involving s,p and d orbitals.

2. p,d and f – Block Elements
p-block elements – Phosphorous compounds; PCl_3, PCl_5 – Oxides. Hydrogen halides, Inter halogen compounds. Xenon fluoride compounds. General Characteristics of d – block elements – Electronic Configuration – Oxidation states of first row transition elements and their colours. Occurrence and principles of extraction: Copper, Silver, Gold and Zinc. Preparation and properties of $CuSO_4$, $AgNO_3$ and $K_2Cr_2O_7$.

Lanthanides – Introduction, electronic configuration, general characteristics, oxidation state – lanthanide contraction, uses, brief comparison of Lanthanides and Actinides.

3. Coordination Chemistry and Solid State Chemistry

Introduction – Terminology in coordination chemistry – IUPAC nomenclature of mononuclear coordination compounds. Isomerism, Geometrical isomerism in 4-coordinate, 6-coordinate complexes. Theories on coordination compounds – Werner's theory (brief), Valence Bond theory. Uses of coordination compounds. Bioinorganic compounds (Haemoglobin and chlorophyll).

Lattice – unit cell, systems, types of crystals, packing in solids; Ionic crystals – Imperfections in solids – point defects. X-Ray diffraction – Electrical Property, Amorphous solids (elementary ideas only)

4. Thermodynamics, Chemical Equilibrium and Chemical Kinetics

I and II law of thermodynamics – spontaneous and non spontaneous processes, entropy, Gibb's free energy – Free energy change and chemical equilibrium – significance of entropy. Law of mass action – Le Chatlier's principle, applications of chemical equilibrium. Rate expression, order and molecularity of reactions, zero order, first order and pseudo first order reaction – half life period. Determination of rate constant and order of reaction . Temperature dependence of rate constant – Arrhenius equation and activation energy.

5. Electrochemistry

Theory of electrical conductance; metallic and electrolytic conductance. Faraday's laws – theory of strong electrolytes – Specific resistance, specific conductance, equivalent and molar conductance – Variation of conductance with dilution – Kohlrausch's Law – Ionic product of water, pH and pH– buffer solutions – use of pH values. Cells – Electrodes and electrode potentials – construction of cell and EMF values, Fuel cells, Corrosion and its prevention.

6. Isomerism in Organic Compounds

Definition, Classification – structural isomerism, stereo isomerism – geometrical and optical isomerism. Optical activity- chirality – compounds containing chiral centres – R, S notation, D, L notation.

7. Alcohols and Ethers

Nomenclature of alcohols – Classification of alcohols - distinction between 1_0, 2_0 and 3_0 alcohols – General methods of preparation of primary alcohols, properties. Methods of preparation of dihydric alcohols: Glycol – Properties – Uses. Methods of preparation of trihydric alcohols - Properties – Uses. Aromatic alcohols – preparation and properties of phenols and benzyl alcohol.

Ethers – Nomenclature of ethers – general methods of preparation of aliphatic ethers - Properties – Uses. Aromatic ethers – Preparation of Anisole – Uses.

8. Carbonyl Compounds

Nomenclature of carbonyl compounds – Comparison of aldehydes and ketones. General methods of preparation of aldehydes – Properties – Uses. Aromatic aldehydes – Preparation of benzaldehyde – Properties and Uses. Ketones – general methods of preparation of aliphatic ketones (acetone) – Properties – Uses. Aromatic ketones – preparation of acetophenone – Properties – Uses, preparation of benzophenone – Properties. Name reactions; Clemmenson reduction, Wolff – Kishner reduction, Cannizzaro reaction, Claisen Schmidt reaction, Benzoin Condensation, Aldol Condensation. Preparation and applications of Grignard reagents.

9. Carboxylic Acids and their derivatives

Nomenclature – Preparation of aliphatic monocarboxylic acids – formic acid – Properties – Uses. Monohydroxy mono carboxylic acids; Lactic acid – Synthesis of lactic acid. Aliphatic dicarboxylic acids; Preparation of oxalic and succinic acids. Aromatic acids; Benzoic and Salicylic acids – Properties – Uses. Derivatives of carboxylic acids; acetyl chloride (CH_3COCl) – Preparation – Properties – Uses. Preparation of acetamide, Properties – acetic anhydride – Preparation, Properties. Preparation of esters – methyl acetate – Properties.

10. Organic Nitrogen Compounds and Biomolecules

Aliphatic nitro compounds – Preparation of aliphatic nitroalkanes – Properties – Uses. Aromatic nitro compounds – Preparation – Properties – Uses. Distinction between aliphatic and aromatic nitro compounds. Amines; aliphatic amines – General methods of preparation – Properties – Distinction between 1_0, 2_0 and 3_0 amines. Aromatic amines – Synthesis of benzylamine – Properties, Aniline – Preparation – Properties – Uses. Differences between aliphatic and aromatic amines. Aliphatic nitriles – Preparation – properties – Uses. Diazonium salts – Preparation of benzene diazoniumchloride – Properties.

Carbohydrates – **Distinction** between sugars and non sugars, structural formulae of glucose, fructose and sucrose, with their linkages, invert sugar – definition, examples of oligo and polysaccharides,

Amino acids – **C**lassification with examples, Peptides-properties of peptide bond, **Lipids** -

Definition, classification with examples, difference between fats, oils and waxes.

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MATHEMATICS

1. Matrices and their Applications

Adjoint, inverse – properties, computation of inverses, solution of system of linear equations by matrix inversion method.

Rank of a matrix – elementary transformation on a matrix, consistency of a system of linear equations, Cramer's rule, non-homogeneous equations, homogeneous linear system and rank method.

Solution of linear programming problems (LPP) in two variables.

2. Trigonometry and Complex Numbers

Definition, range, domain, principal value branch, graphs of inverse trigonometric functions and their elementary properties.

Complex number system - conjugate, properties, ordered pair representation.

Modulus **–** properties, geometrical representation, polar form, principal value, conjugate, sum, difference, product, quotient, vector interpretation, solutions of polynomial equations, De Moivre's theorem and its applications.

Roots of a complex number - n_{th} roots, cube roots, fourth roots.

3. Analytical Geometry of two dimensions

Definition of a conic – general equation of a conic, classification with respect to the general equation of a conic, classification of conics with respect to eccentricity.

Equations of conic sections (parabola, ellipse and hyperbola) in standard forms and general forms- Directrix, Focus and Latus-rectum - parametric form of conics and chords. - Tangents and normals – Cartesian form and parametric form- equation of chord of contact of tangents from a point (x_1, y_1) to all the above said curves.

Asymptotes, Rectangular hyperbola **–** Standard equation of a rectangular hyperbola.

4. Vector Algebra

Scalar Product – angle between two vectors, properties of scalar product, and applications of dot product. Vector product, right handed and left handed systems, properties of vector product, applications of cross product.

Product of three vectors – Scalar triple product, properties of scalar triple product, vector triple product, vector product of four vectors, scalar product of four vectors.

5. Analytical Geometry of Three Dimensions

Direction cosines – direction ratios - equation of a straight line passing through a given point and parallel to a given line, passing through two given points, angle between two lines.

Planes – equation of a plane, passing through a given point and perpendicular to a line, given the distance from the origin and unit normal, passing through a given point and parallel to two given lines, passing through two given points and parallel to a given line, passing through three given non-collinear points, passing through the line of intersection of two given planes, the distance between a point and a plane, the plane which contains two given lines (co-planar lines), angle between a line and a plane.

Skew lines **-** shortest distance between two lines, condition for two lines to intersect, point of intersection, collinearity of three points. Sphere – equation of the sphere whose centre and radius are given, equation of a sphere when the extremities of the diameter are given.

6. Differential Calculus

Limits, continuity and differentiability of functions - Derivative as a rate of change, velocity, acceleration, related rates, derivative as a measure of slope, tangent, normal and angle between curves.

Mean value theorem - Rolle's Theorem, Lagrange Mean Value Theorem, Taylor's and Maclaurin's series, L' Hospital's Rule, stationary points, increasing, decreasing, maxima, minima, concavity, convexity and points of inflexion.

Errors and approximations **–** absolute, relative, percentage errors - curve tracing, partial derivatives, Euler's theorem.

7. Integral Calculus and its Applications

Simple definite integrals – fundamental theorems of calculus, properties of definite integrals.

Reduction formulae – reduction formulae for $\int \sin^n x \, dx$ and $\int \cos^n x \, dx$, Bernoulli's formula.

Area of bounded regions, length of the curve.

8. Differential Equations

Differential equations - formation of differential equations, order and degree, solving differential equations (1_{st} order), variables separable, homogeneous, linear equations and applications.

Second order linear differential equations **-** second order linear differential equations with constant co-efficients, finding the particular integral if $f(x) = e_{mx}$, sin mx, cos mx, x, x_2.

9. Probability Distributions

Probability – Axioms – Addition law - Conditional probability – Multiplicative law - Baye's Theorem - Random variable - probability density function, distribution function, mathematical expectation, variance

Theoretical distributions-discrete distributions (Binomial, Poisson distributions)- Continuous distributions (Normal distribution).

10. Discrete Mathematics

Functions–Relations –Sequence and series (AP, GP, HP)- Binomial theorem-Basics of counting.

Mathematical logic – logical statements, connectives, truth tables, logical equivalence, tautology, contradiction.

Groups-binary operations, semi groups, monoids, groups, order of a group, order of an element, properties of groups.

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BIOLOGY

1. Taxonomy

Need for classification; three domains of life. Linnaean, Whittaker, Bentham and Hooker systems of classification. Salient features and classification of non-chordates up to phyla levels and chordates up to class levels. Morphology and anatomy of flowering plants. Structural organization in insects(cockroach)

2. Cell and Molecular Biology

Cell theory. Prokaryotic cell and it's ultrastructure. Eukaryotic cell- cell wall, cell membrane, cytoskeleton, nucleus, chloroplast, mitochondria, endoplasmic reticulum, Golgi bodies, ribosomes, lysosomes, vacuoles and centrosomes. Cell cycle and division - amitosis, mitosis

and meiosis. Search for genetic material; structure of DNA and RNA; replication, transcription, genetic code, translation, splicing, gene expression and regulation (lac operon) and DNA repair.

3. Reproduction

Asexual reproduction – binary fission, sporulation, budding, gemmule formation and fragmentation. Vegetative propagation in plants, sexual reproduction in flowering plants and structure of flowers. Pollination, fertilization, development of seeds and fruits, seed dispersal, apomixis, parthenocarpy and poly-embryony. Human reproductive system. Gametogenesis, menstrual cycle, fertilization, implantation, embryo development upto blastocyst formation, pregnancy, parturition and lactation. Assisted reproductive technologies.

4. Genetics and evolution

Chromosomes - structure and types, linkage and crossing over, recombination of chromosomes, mutation and chromosomal aberrations. Mendelian inheritance, chromosomal theory of inheritance, deviation from Mendelian ratio (incomplete dominance, co-dominance, multiple allelism, pleiotrophy), sex linked inheritance and sex determination in humans. Darwinism, neo Darwinism, Hardy and Weinberg's principle and factors affecting the equilibrium: selection, mutation, migration and random genetic drift.

5. Human health and diseases

Pathogens, parasites causing human diseases (malaria, dengue, chickengunia, filariasis, ascariasis, typhoid, pneumonia, common cold, amoebiasis, ring worm) and their control. Basic concepts of immunology, vaccines, antibiotics, cancer, HIV and AIDS. Adolescence, drug and alcohol abuse.

6. Biochemistry

Structure and function of carbohydrates, lipids and proteins. Enzymes – types, properties and enzyme action. Metabolism - glycolysis, fermentation, Kreb's cycle and pentose phosphate pathway.

7. Plant physiology

Movement of water, food, nutrients, gases and minerals. Passive diffusion, facilitated diffusion, and active transport. Imbibition, osmosis, apoplast and symplast transport and guttation.

Macro and micronutrients and their deficiency symptoms. Transpiration, photosynthesis (light and dark reactions) and electron transport chain. Hormones and growth regulators, photo-periodism and vernalization. Nitrogen cycle and biological nitrogen fixation.

8. Human physiology

Digestion and absorption, breathing and respiration, body fluids and circulation, excretory system, endocrine system, nervous system, skeletal and muscular systems. Locomotion and movement, growth, aging and death. Hormones - types of hormones, functions and disorders.

9. Biotechnology and its applications

Recombinant DNA technology, applications in health, agriculture and industries; genetically modified organisms; Human insulin, vaccine and antibiotic production. Stem cell technology

and gene therapy. Apiculture and animal husbandry. Plant breeding, tissue culture, single cell protein, fortification, Bt crops and transgenic animals. Microbes in food processing, sewage treatment, waste management and energy generation. Biocontrol agents and biofertilizers. Bio-safety issues, biopiracy and patents. Human and rice genome projects. DNA fingerprinting.

10. Biodiversity, ecology and environment

Ecosystems: components, types, pyramids, nutrient cycles (carbon and phosphorous), ecological succession and energy flow in an ecosystem; Biodiversity - concepts, patterns, importance, conservation, hot spots, endangered organisms, extinction, Red data book, botanical gardens, national parks, sanctuaries, museums, biosphere reserves and Ramsar sites. Environmental issues: pollution and its control.Solid and radioactive waste management. Climate change impact and its mitigation. Population attributes - growth, birth and death rate and age distribution.