

SCHOOL OF AERONAUTICS

ENTRANCE EXAMINATION SYLLABUS

SYLLABUS FOR PHYSICS

1: Units and Measurement

Units for measurement, system of units-S.I., fundamental and derived units, measurements-errors in measurement-significant figures, dimensions-dimensional analysis-applications.

2: Mechanics

Motion in one dimension-uniform and non-uniform motion-uniformly accelerated motion-scalar and vector quantities-Newton's laws of motion-force and inertia-impulse and momentum-law of conservation of linear momentum-applications-motions in two dimension- projectile motion-uniform circular motion-friction-laws of friction-applications centripetal force-centre of mass-torque-angular momentum and its conservation - moment of inertia-theorems of moment of inertia-work energy- potential energy and kinetic energy-power collision-elastic and inelastic collisions.

3: Gravitation

Mechanics of Solids and Fluids The universal law of gravitation, acceleration due to gravity-variation of 'g' with altitude, latitude and depth-gravitation potential-escape velocity and orbital velocity - geostationary satellites-Kepler's laws of planetary motion. Solids-elastic behaviour, stress-strain-Hooke's law-Modulli of elasticity-relation between them-surface tension capillarity- applications-viscosity-Poiseuille's formula-Stokes law applications streamline and turbulent flow-Reynolds number-Bernoulli's theorem-applications

4: Oscillations and Wave Motion

Periodic motion-simple harmonic motion-equations of motion oscillations of spring-simple pendulum-free, forced and damped oscillations-resonance-applications-wave motions-longitudinal and transverse waves velocity of wave motion in different media-Newton's formula-Laplace's correction-super position of waves progressive and standing waves-sono meter-air columns-Doppler effect and its applications.

5: Heat and Thermodynamics

Kinetic theory of gases-postulates-pressure of a gas-specific heat capacity-relation between C_p and C_v first law of thermodynamics thermodynamical processes-isothermal and adiabatic-reversible and irreversible process-second law of thermodynamics-Carnot's engine heat transfer-conduction-convection radiation-thermal conductivity of solids-black body radiations-Kirchoff's law-Wien's displacement law- Stefan's law-Newton's law of cooling.

6: Ray and Wave Optics and Magnetism

Reflection and refraction of light-total internal reflection-velocity of light determination-deviation and dispersion of light by a prism-lens formula magnification- power of lens-Combination of thin lenses in contact microscope- astronomical telescope-wave front-Huygens principle-wave nature of light- interference-Young's double slit experiment-diffraction and polarization

7: Electricity and Magnetism

Electrostatics-Coulomb's inverse square law-dielectric constant-electric field-electric lines of force-electric dipole-electric potential-potential difference-electric flux-Gauss theorem-electrostatic induction-capacitor capacitors in parallel and series-action of points-lightning arrester electric current-drift velocity of electrons-Ohm's law-electrical resistivity and conductivity-super conductivity-Kirchoff's law Wheatstone's bridge-principle of potentiometer-electric power- Earth's magnetic field and magnetic elements-magnetic field due to a magnetic dipole-torque on a magnetic dipole-tangent law tangent galvano meter deflection magnetometer-magnetic properties of a material-dia, para and ferromagnetic materials-applications magnetic effects of electric current-Bio Savart law-force on a moving charge in an uniform magnetic field-moving coil galvanometer-conversion of a galvanometer into voltmeter and ammeter-Faraday's law-Lenz law of electromagnetic induction-self inductance-mutual inductance Flemming's right hand rule-methods of inducing emf-eddy current. Alternating currents-LCR series circuit AC generator-transformer

8: Atomic Physics and Relativity

Atomic structure-properties of cathode rays and positive rays-specific charge of an electron-atom model Thomson atom model-Rutherford atom model-Bohr atom model-merits and demerits-quantum numbers X-rays-production-properties-Bragg's law-Bragg's X-ray spectro meter photo electric effect-lasers pontaneous and stimulated emission-laser action-characteristics of laser light-ruby laser-applications of laser relativity-Einstein's mass energy relation-variation of mass with velocity.

9: Dual Nature of Matter and Nuclear Physics

Matter waves-wave nature of particles-De Broglie wavelength-electron microscope. Nuclear properties; radius, mass, binding energy, density, isotopes, mass defect-Bainbridge mass spectrometer-nuclear forces neutron discovery-radioactivity- α , β and γ decay-half life and mean life-artificial radio activity radio isotopes-radio carbon dating-radiation hazards. Nuclear fission-nuclear reactor-nuclear fusion hydrogen bomb cosmic rays-elementary particles

10: Electronics and Communication

Semiconductors-doping-types-PN junction diode-biasing-diode as a Rectifier-transistors-transistor characteristics-amplifier-gain-feedback in amplifiers-logic gates-basic logic gates-NOT, OR, AND, NOR, NAND-universal gates-De Morgan's theorems-space communication propagation of electromagnetic waves in atmosphere-sky and space wave propagation-modulation types-demodulation-micro waves radars.

SYLLABUS FOR CHEMISTRY

1: Some Basic Concepts in Chemistry

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

2: States of Matter

Classification of matter into solid, liquid and gaseous states. Solid State: Classification of solids: molecular, ionic, covalent and metallic solids, amorphous and crystalline solids (elementary idea); Bragg's Law and its applications; unit cell and lattices, packing in solids (fcc, bcc and hcp lattices), voids, calculations involving unit cell parameters, imperfection in solids; electrical, magnetic and dielectric properties. Liquid State: Properties of liquids - vapour pressure, viscosity and surface tension and effect of temperature on them (qualitative treatment only). Gaseous State: Measurable properties of gases; Gas laws-Boyle's law, Charles' law, Graham's law of diffusion, Avogadro's law, Dalton's law of partial pressure; concept of absolute scale of temperature; ideal gas equation, kinetic theory of gases (only postulates); concept of average, root mean square and most probable velocities; real gases, deviation from ideal behaviour, compressibility factor, Van der Waals equation, liquefaction of gases, critical constants.

3: Chemical Families

Periodic Properties Modern periodic law and present form of the periodic table, s & p block elements, periodic trends in properties of elements, atomic and ionic radii, ionization enthalpy, electron gain enthalpy, valence, oxidation states and chemical reactivity. Transition elements-d-block elements, inner transition elements-f-block elements. Ionization energy, electron affinity, lanthanides and actinides-general characteristics. Coordination Chemistry: Coordination compounds, nomenclature: terminology - Werner's coordination theory. Applications of coordination compounds.

4: Atomic Structure

Discovery of sub-atomic particles (electron, proton and neutron); Thomson and Rutherford atomic models and their limitations; nature of electromagnetic radiation, photoelectric effect; spectrum of hydrogen atom, Bohr model of hydrogen atom-its postulates, derivation of the relations for energy of the electron and radii of the different orbits, limitations of Bohr's model; dual nature of matter, De-Broglie's relationship, Heisenberg uncertainty principle. Elementary ideas of quantum mechanics, quantum mechanical model of atom, its important features, various quantum numbers (principal, angular momentum and magnetic quantum numbers) and their significance; shapes of s, p and d-orbitals, electron spin and spin quantum number; rules for filling electrons in orbitals-Aufbau principle, Pauli's exclusion principle and Hund's rule, electronic configuration of elements, extra stability of half filled and completely filled orbitals.

5: Chemical Bonding and Molecular Structure

Covalent bonding: Concept of electro negativity, Fajan's rule, dipole moment; Valence Shell Electron Pair Repulsion (VSEPR) theory and shapes of simple molecules. Quantum mechanical approach to covalent bonding: Valence bond theory—Its important features, concept of hybridization involving s, p and d orbitals; resonance. Molecular orbital theory—Its important features, LCAOs, types of molecular orbitals (bonding, anti-bonding), sigma and pi-bonds, molecular orbital electronic configurations of homonuclear diatomic molecules, concept of bond order, bond length and bond energy. Elementary idea of metallic bonding. Hydrogen bonding and its applications. Extractive metallurgy of sodium, lithium, properties of alkali metals, basic nature of oxides and hydroxides, compounds of alkaline earth metals, compounds of boron. Oxides, carbides, halides and sulphides of carbon group. Oxides— classification—acidic, basic, neutral, peroxide and amphoteric oxides.

6: Chemical Energetics

First law of thermodynamics, Energy changes during a chemical reaction, Internal energy and Enthalpy, Hess's law of constant heat summation, numerical, based on these concepts. Enthalpies of reactions (enthalpy of neutralization, enthalpy of combustion, enthalpy of fusion and vaporization).

7: Chemical Thermodynamics

Second law of thermodynamics—Spontaneity of processes; S of the universe and G of the system as criteria for spontaneity, G° (Standard Gibbs energy change) and equilibrium constant.

8: Solutions

Different methods for expressing concentration of solution—Molality, molarity, mole fraction, percentage (by volume and mass both), vapour pressure of solutions and Raoult's law—ideal and non-ideal solutions, vapour pressure-composition plots for ideal and non-ideal solutions; colligative properties of dilute solutions—relative lowering of vapour pressure, depression of freezing point, elevation of boiling point and osmotic pressure; determination of molecular mass using colligative properties; abnormal value of molar mass, Van't Hoff factor and its significance.

9: Chemical Equilibrium

Meaning of equilibrium, concept of dynamic equilibrium. Equilibria involving physical processes: Solid liquid, liquid-gas and solid-gas equilibria, Henry's law, Equilibria involving chemical processes: Law of chemical equilibrium, equilibrium constants (K_p and K_c) and their significance, significance of G and G° in chemical equilibria, factors affecting equilibrium concentration, pressure, temperature, effect of catalyst; Le Chatelier's principle. Ionic equilibrium: Weak and strong electrolytes, ionization of electrolytes, various concepts of acids and bases (Arrhenius, Bronsted-Lowry and Lewis) and their ionization, acid-base equilibria (including multistage ionization) and ionization constants, ionization of water, pH scale, common ion effect, hydrolysis of

salts and pH of their solutions, solubility of sparingly soluble salts and solubility products, buffer solutions.

10: Electrochemistry

Electrolytic and metallic conduction, conductance in electrolytic solutions, specific and molar conductivities and their variation with concentration: Kohlrausch's law and its applications. Electrochemical cells—Electrolytic and Galvanic cells, different types of electrodes, electrode potentials including standard electrode potential, half-cell and cell reactions, emf of a galvanic cell and its measurement; Nernst equation and its applications; dry cell and lead accumulator; fuel cells; corrosion and its prevention.

11: Surface Chemistry

Chemical Kinetics and Catalysis Adsorption—Physisorption and chemisorption and their characteristics, factors affecting adsorption of gases on solids-Freundlich and Langmuir adsorption isotherms, adsorption from solutions. Catalysis— Homogeneous and heterogeneous, activity and selectivity of solid catalysts, enzyme catalysis and its mechanism. Colloidal state—Distinction among true solutions, colloids and suspensions, classification of colloids-lyophilic, lyophobic; multi molecular, macromolecular and associated colloids (micelles), preparation and properties of colloids-Tyndall effect, Brownian movement, electrophoresis, dialysis, coagulation and flocculation; emulsions and their characteristics. Rate of reaction, instantaneous rate of reaction and order of reaction. Factors affecting rates of reactions—factors affecting rate of collisions encountered between the reactant molecules, effect of temperature on the reaction rate, concept of activation energy, catalyst. Rate law expression. Order of a reaction (with suitable examples). Units of rates and specific rate constants. Order of reaction and effect of concentration (study will be confined to first order only). Theories of catalysis adsorption theory-some of important industrial process using catalysts. Nuclear Chemistry: Radioactivity: isotopes and isobars: Properties of α , β and γ rays; Kinetics of radioactive decay (decay series excluded), carbon dating; Stability of nuclei with respect to proton-neutron ratio; Brief discussion on fission and fusion reactions.

12: Purification and Characterisation of Organic Compounds

Purification—Crystallization, sublimation, distillation, differential extraction and chromatography—principles and their applications. Qualitative analysis—Detection of nitrogen, sulphur, phosphorus and halogens. Quantitative analysis (basic principles only)—Estimation of carbon, hydrogen, nitrogen, halogens, sulphur, phosphorus. Calculations of empirical formulae and molecular formulae; numerical problems in organic quantitative analysis.

13: Some Basic Principles of Organic Chemistry

Tetravalency of carbon; shapes of simple molecules—hybridization (s and p); classification of organic compounds based on functional groups: -C=C- , -C C- and those containing halogens, oxygen, nitrogen and sulphur; homologous series; isomerism—structural and stereoisomerism. Nomenclature (Trivial and IUPAC) Covalent bond fission— Homolytic and heterolytic: free radicals, carbocations and carbanions; stability of carbocations and free radicals, electrophiles and nucleophiles. Electronic

displacement in a covalent bond—inductive effect, electromeric effect, resonance and hyperconjugation. Common types of organic reactions— Substitution, addition, elimination and rearrangement.

14: Hydrocarbons

Classification, isomerism, IUPAC nomenclature, general methods of preparation, properties and reactions. Alkanes—Conformations: Sawhorse and Newman projections (of ethane); mechanism of halogenation of alkanes. Alkenes—Geometrical isomerism; mechanism of electrophilic addition: addition of hydrogen, halogens, water, hydrogen halides (Markownikoff's and peroxide effect); ozonolysis, oxidation, and polymerization. Alkynes—Acidic character; addition of hydrogen, halogens, water and hydrogen halides; polymerization. aromatic hydrocarbons— nomenclature, benzene—structure and aromaticity; mechanism of electrophilic substitution: halogenation, nitration, Friedel-Craft's alkylation and acylation, directive influence of functional group in mono Substituted benzene.

15: Organic Compounds Containing Oxygen

General methods of preparation, properties, reactions and uses. Alcohols: Identification of primary, secondary and tertiary alcohols; mechanism of dehydration. Reaction of hydroxy derivatives. Phenols: Acidic nature, electrophilic substitution reactions: halogenation, nitration and sulphonation, Reimer—Tiemann reaction. Addition to $>C=O$ group, relative reactivities of aldehydes and ketones. Ethers: Structure. Aldehyde and Ketones: Nature of carbonyl group; Nucleophilic addition reactions (addition of HCN, NH_3 and its derivatives), Grignard reagent; oxidation; reduction (Wolff Kishner and Clemmensen); acidity of— hydrogen, aldol condensation, Cannizzaro reaction, Haloform reaction; Chemical tests to distinguish between aldehydes and Ketones. Carboxylic acids: Reactions, Acidic strength and factors affecting it; reactions of acid derivatives.

16: Organic Compounds Containing Nitrogen

General methods of preparation, properties, reactions and uses. Amines: Nomenclature, classification, structure, basic character and identification of primary, secondary and tertiary amines and their basic character. Diazonium salts: Importance in synthetic organic chemistry.

17: Polymers

General introduction and classification of polymers, general methods of polymerization— addition and condensation, copolymerization; natural and synthetic rubber and vulcanization; some important polymers with emphasis on their monomers and uses - polythene, nylon, polyester and bakelite.

18: Bio Molecules

Carbohydrates—Classification: aldoses and ketoses; monosaccharides (glucose and fructose), constituent monosaccharides of oligosaccharides (sucrose, lactose, maltose) and polysaccharides (starch, cellulose, glycogen). Proteins—Elementary Idea of—amino acids, peptide bond, polypeptides; proteins: primary, secondary, tertiary and quaternary structure (qualitative idea only), denaturation of proteins, enzymes. vitamins—

Classification and functions. Nucleic acids—Chemical constitution of DNA and RNA. Biological functions of nucleic acids.

19: Chemistry in Everyday Life Chemicals in medicines

Analgesics, tranquilizers, antiseptics, disinfectants, antimicrobials, antifertility drugs, antibiotics, antacids. Antihistamins—their meaning and common examples. Chemicals in food preservatives, artificial sweetening agents—common examples. Cleansing agents—Soaps and detergents, cleansing action.

SYLLABUS FOR MATHEMATICS

1: Sets, Relations and Functions

Sets and their representations, union, intersection and complements of sets and their algebraic properties, relations, equivalence relations, mappings, one-one, into and onto mappings, composition of mappings.

2: Complex Numbers

Complex numbers in the form $a+ib$ and their representation in a plane. Argand diagram. Algebra of complex numbers, modulus and argument (or amplitude) of a complex number, square root of a complex number. Cube roots of unity, triangle inequality.

3: Matrices and Determinants

Determinants and matrices of order two and three, properties of determinants, evaluation of determinants. Addition and multiplication of matrices, adjoint and inverse of matrix.

4: Applications of Matrices and Determinants

Computing the rank of a matrix—test of consistency and solution of simultaneous linear equations using determinants and matrices.

5: Quadratic Equations

Quadratic equations in real and complex number system and their solutions. Relation between roots and coefficients, nature of roots, formation of quadratic equations with given roots; symmetric functions of roots, equations reducible to quadratic equations.

6: Permutations and Combinations

Fundamental principle of counting: permutation as an arrangement and combination as selection, meaning of $P(n,r)$ and $C(n,r)$. Simple applications.

7: Mathematical Induction and its Applications

Stating and interpreting the principle of mathematical induction. Using it to prove formula and facts.

8: Binomial theorem and its Applications

Binomial theorem for a positive integral index; general term and middle term; Binomial theorem for any index. Properties of binomial coefficients. Simple applications for approximations.

9: Sequences and Series

Arithmetic, geometric and harmonic progressions. Insertion of arithmetic, geometric and harmonic means between two given numbers. Relation between A.M., G.M. and H.M. arithmetic, geometric series, exponential and logarithmic series.

10: Differential Calculus

Polynomials, rational, trigonometric, logarithmic and exponential functions. Inverse functions. Graphs of simple functions. Limits, continuity, differentiation of the sum, difference, product and quotient of two functions, differentiation of trigonometric, inverse trigonometric, logarithmic, exponential, composite and implicit functions, derivatives of order up to two.

11: Applications of Differential Calculus

Rate of change of quantities, monotonic-increasing and decreasing functions, maxima and minima of functions of one variable, tangents and normals, Rolle's and Lagrange's mean value theorems.

12: Integral Calculus

Integral as an anti-derivative. Fundamental integrals involving algebraic, trigonometric, exponential and logarithmic functions. Integration by substitution, by parts and by partial fractions. Integration using trigonometric identities. Integral as limit of a sum. Properties of definite integrals. Evaluation of definite integrals; Determining areas of the regions bounded by simple curves.

13: Differential Equations

Ordinary differential equations, their order and degree. Formation of differential equations. Solution of differential equations by the method of separation of variables. Solution of homogeneous and linear differential equations and those of the type $\frac{d^2y}{dx^2} = f(x)$.

14: Straight Lines in Two Dimensions

Cartesian system of rectangular co-ordinates in plane, distance formula, area of a triangle, condition for the collinearity of three points and section formula, centroid and in-centre of a triangle, locus and its equation, translation of axes, slope of a line, parallel and perpendicular lines, intercepts of a line on the coordinate axes. Various forms of equations of a line, intersection of lines, angles between two lines, conditions for concurrence of three lines, distance of a point from a line. Equations of internal and external bisectors of angles between two lines, coordinates of centroid, orthocentre and circumcentre of a triangle, equation of family of lines passing through the point of intersection of two lines, homogeneous equation of second degree in x and y , angle between pair of lines through the origin, combined equation of the bisectors of the

angles between a pair of lines, condition for the general second degree equation to represent a pair of lines, point of intersection and angle between two lines.

15: Circles in Two Dimensions

Standard form of equation of a circle, general form of the equation of a circle, its radius and centre, equation of a circle in the parametric form, equation of a circle when the end points of a diameter are given, points of intersection of a line and a circle with the centre at the origin and condition for a line to be tangent to the circle, length of the tangent, equation of the tangent, equation of a family of circles through the intersection of two circles, condition for two intersecting circles to be orthogonal.

16: Conic Sections in Two Dimensions

Sections of cones, equations of conic sections (parabola, ellipse and hyperbola) in standard form, condition for $y = mx+c$ to be a tangent and point(s) of tangency.

17: Vector Algebra

Vectors and scalars, addition of vectors, components of a vector in two dimensions and three dimensional space, scalar and vector products, scalar and vector triple product. Application of vectors to plane geometry.

18: Measures of Central Tendency and Dispersion

Calculation of mean, median and mode of grouped and ungrouped data. Calculation of standard deviation, variance and mean deviation for grouped and ungrouped data.

19: Probability

Probability of an event, addition and multiplication theorems of probability and their applications; Conditional probability; Baye's theorem, probability distribution of a random variate; binomial and poisson distributions and their properties.

20: Trigonometry

Trigonometrical identities and equations. Inverse trigonometric functions and their properties. Properties of triangles, including, incentre, circumcentre and orthocenter, solution of triangles.