ENGINEERING/MEDICAL ENTRANCE EXAMINATION - 2005
PHYSICS

UNIT 1: Introduction and Measurement

Physics – Scope and excitement; Physics in relation to science, society and technology – inventions, names of scientists and their fields, nobel prize winners and topics, current developments in physical sciences and related technology.

Units for measurement – systems of units, S .I units, conversion from other systems to S.I units.

Fundamental and derived units

Measurement of length, mass and time, least count in measuring instruments (eg. vernier calipers, screw gauge etc), Dimensional analysis and applications, order of magnitude, accuracy and errors in measurement, random and instrumental errors, significant figures and rounding off principles.

UNIT 2 : Description of motion in one dimension

Objects in motion in one dimension – Motion in a straight line, uniform motion – its graphical representation and formulae; speed and velocity - instantaneous velocity; ideas of relative velocity with expressions and graphical representations; Uniformly accelerated motion, position – time graph, velocity – time graph and formulae. Elementary ideas of calculus – differentiation and integration – applications to motion.

UNIT 3 : Description of motion in two and three dimensions

Vectors and scalars, vectors in two and three dimensions, unit vector, addition and multiplication, resolution of vector in a plane, rectangular components, scalar and vector products.

Motion in two dimensions – projectile motion, ideas of uniform circular motion, linear and angular velocity, relation between centripetal acceleration and angular speed.

UNIT 4 : Laws of Motion

Force and inertia, first law of motion, momentum, second law of motion, forces in nature, impulse, third law of motion, conservation of linear momentum, examples of variable mass situation, rocket propulsion, equilibrium of concurrent forces.

Static and kinetic friction, laws of friction, rolling friction, lubrication.

Inertial and non-inertial frames (elementary ideas); Dynamics of uniform circular motion – centripetal and centrifugal forces, examples : banking of curves and centrifuge.

UNIT 5 : Work, energy and power

Work done by a constant force and by a variable force, units of work –

Energy – kinetic and potential forms, power, work-energy theorem.

Elastic and inelastic collisions in one and two dimensions.

Gravitational potential energy and its conversion to kinetic energy, spring constant, potential energy of a spring, Different forms of energy, mass – energy equivalence (elementary ideas), conservation of energy, conservative and non-conservative forces.

UNIT 6: Motion of system of particles and rigid body rotation.

Centre of mass of a two particle system, generalisation to N particles, momentum conservation and center of mass motion, applications to some familiar systems, center of mass of rigid body. Moment of a force, torque, angular momentum, physical meaning of angular momentum, conservation of angular momentum with some examples, eg. planetary motion.

Equilibrium of rigid bodies, rigid body rotation and equation of rotational motion, comparison of linear and rotational motions, moment of inertia and its physical significance, radius of gyration, parallel and perpendicular axes theorems (statements only), moment of inertia of circular ring and disc, cylinder rolling without slipping.

UNIT 7 : Gravitation

Universal law of gravitation, gravitational constant (G) and acceleration due to gravity (g), weight and gravitation, variation of g with altitude, latitude, depth and rotation of earth.

Mass of earth, gravitational potential energy near the surface of the earth, gravitational potential, escape velocity, orbital velocity of satellite, weightlessness, motion of geostationary and polar satellites, statement of Kepler's laws of planetary motion, proof of second and third laws, relation between inertial and gravitational masses.

UNIT 8 : Mechanics of solids and fluids.

Interatomic and intermolecular forces, different states of matter.

Solids : Crystalline and amorphous solids, Hooke's law, stress – strain relationships, Youngs modulus, bulk modulus, shear modulus of rigidity, some practical examples

Fluids : Pressure due to fluid column, Pascal's law and its applications (hydraulic lift and hydraulic brakes), effect of gravity on fluid pressure, Buoyancy, laws of floatation and Archimedes principles, atmospheric pressure. Surface energy and surface tension, angle of contact, examples of drops and babbles, capillary rise, detergents

and surface tension, viscosity, sphere falling through a liquid column, Stokes law, streamline flow, Reynold's number, equation of continuity, Bernoulli's theorum and applications.

UNIT 9 : Heat and Thermodynamics

Kinetic theory of gases, assumptions, concept of pressure, kinetic energy and temperature, mean-rms and most probable speed, degrees of freedom, statement of law of equipartition of energy, concept of mean free path and Avogadros' number

Thermal equilibrium and temperatures, zeroth law of thermodynamics, Heat-work and internal energy, Thermal expansion – thermometry. First law of thermodynamics and examples, specific heat, specific heat of gases at constant volume and constant pressure, specific heat of solids, Dulong and Petit's law.

Thermodynamical variables and equation of state, phase diagrams, ideal gas equation, isothermal and adiabatic processes, reversible and irreversible processes, Carnot engines, refrigerators and heat pumps, efficiency and coefficient performance of heat engines , ideas of second law of thermodynamics with practical applications

Thermal radiation – Stefan-Boltzmann law, Newton's law of cooling, Kirchoff's law and black body radiation, Wien's displacement law, solar constant and surface temperature of the sun.

UNIT 10 Oscillations

Periodic motion – period, frequency, displacement as a function of time and periodic functions; Simple harmonic motion (S.H.M) and its equation, uniform circular motion and simple harmonic motion, oscillations of a spring, restoring force and force constant, energy in simple harmonic motion, kinetic and potential energies, simple pendulum – derivation of expression for the period; forced and damped oscillations and resonance (qualitative ideas only), coupled oscillations

UNIT 11. Waves

Longitudinal and transverse waves, wave motion, displacement relation for a progressive wave, speed of a traveling wave, principle of superposition of waves, reflection of waves, standing waves in strings and pipes, fundamental mode and harmonics, beats,

Doppler effect of sound with applications.

UNIT 12: Electrostatics

Frictional electricity; Properties of electric charges - conservation, additivity and quantisation.

Coulomb's law – Forces between two point electric charges, Forces between multiple electric charges; Superposition principle and continuous charge distribution.

Electric field and its physical significance, electric field due to a point charge, electric field lines; Electric dipole, electric field due to a dipole and behavior and dipole in a uniform electric field.

Electric potential-physical meaning, potential difference, electric potential due to a point charge, a dipole and system of charges; Equipotential surfaces, Electrical potential energy of a system of point charges, electric dipoles in an electrostatic field.

Electric flux, statement of Gauss' theorem-its application to find field due to an infinitely long straight wire, uniformly charged infinite plane sheet and uniformly charged thin spherical shell.

Conductors and insulators-presence of free charges and bound charges; Dielectrics and electric polarization, general concept of a capacitor and capacitance, combination of capacitors in series and in parallel, energy stored in a capacitor, capacitance of a parallel plate capacitor with and without dielectric medium between the plates, Van de Graff generator.

UNIT 13: Current Electricity

Electric current, flow of electric charges in a metallic conductor, drift velocity and mobility, their relation with electric current; Ohm's law, electrical resistance, V-I characteristics, limitations of Ohm's law, electrical resistivity and conductivity, classification of materials in terms of conductivity; Superconductivity (elementary idea); Carbon resistors, colour code for carbon resistors; combination of resistances - series and parallel. Temperature dependence of resistance. Internal resistance of a cell, Potential difference and emf of a cell, combination of cells in series and in parallel.

Kirchoff's laws-illustration by simple applications, Wheatstone bridge and its applications, Meter bridge.

Potentiometer - principle and applications to measure potential difference, comparison of emf of two cells and determination of internal resistance of a cell.

Electric power, thermal effects of current and Joule's law; Chemical effects of current, Faraday's laws of electrolysis, Electro-chemical cells, Primary and secondary cells, solid state cells.

Thermoelectricity-origin, elementary ideas of Seebeck effect, Peltier effect and Thomson effect. Thermocouple, Thermo emf, neutral and inversion temperatures, Measurement of temperature using a thermo- couple.

UNIT 14: Magnetic Effect of Current and Magnetism

Concept of a magnetic field, Oersted's experiment, Biot-Savart's law, magnetic field due to an infinitely long current carrying straight wire and a circular loop, Ampere's circuital law and its applications to straight and toroidal solenoids. Force on a moving charge in a uniform magnetic field, cyclotron. Force on current carrying conductor

and torque on current loop in magnetic fields, force between two parallel current carrying conductors, definition of the ampere. Moving coil galvanometer and its conversion into ammeter and voltmeter.

Current loop as a magnetic dipole, magnetic moment, torque on a magnetic dipole in a uniform magnetic field, Lines of force in magnetic field. Comparison of a bar magnet and solenoid. Earth's magnetic field and magnetic elements, tangent galvanometer, vibration magnetometer. Para, dia and ferromagnetic substances with examples. Electromagnets and permanent magnets.

UNIT 15: Electromagnetic Induction and Alternating current

Electromagnetic induction, Faraday's laws, Induced e.m.f. and current, Lenz's law, Eddy currents, self and mutual inductance.

Alternating current, peak and rms value of alternating current/voltage, reactance and impedance, L.C. oscillations, LCR series circuit. (Phasor diagram), Resonant circuits and Q-factor; power in A.C. circuits, wattless current.

AC generator and Transformer.

UNIT 16: Electromagnetic Waves

Properties of electromagnetic waves and Maxwell's contributions (qualitative ideas), Hertz's experiments, Electromagnetic spectrum (different regions and applications), propagation of electromagnetic waves in earth's atmosphere.

UNIT 17: Optics

Refraction of light, total internal reflection and its applications, spherical lenses, thin lens formula, lens maker's formula; Magnification, Power of a lens, combination of thin lenses in contact; Refraction and dispersion of light due to a prism, Scattering of light, Blue colour of the sky and appearance of the sun at sunrise and sunset.

Optical instruments, Compound microscope, astronomical telescope (refraction and reflection type) and their magnifying powers. Spectrometer -its use for determination of refractive index of the material of a prism.

Wave front and Huygen's principle. Reflection and refraction of plane wave at a plane surface using wave fronts (qualitative idea); Interference-Young's double slit experiment and expression for fringe width, coherent sources and sustained interference of light; Diffraction due to a single slit, width of central maximum, difference between interference and diffraction, resolving power of microscope and telescope; Polarisation, plane polarised light, Brewster's law, Use of polarised light and polaroids.

UNIT 18: Dual Nature of Matter and Radiations

Photoelectric effect, Einstein photoelectric equation - particle nature light, photo-cell, Matter waves - wave nature of particles. De Broglie relation, Davisson and Germer experiment.

UNIT 19: Atomic Nucleus

Alpha particle scattering experiment, size of the nucleus - composition of the nucleus - protons and neutrons. Nuclear instability - Radioactivity-Alpha, Beta and Gamma particle/rays and their properties, radio- active decay laws, Simple explanation of ??decay, ?-decay and ??decay; mass-energy relation, mass defect, Binding energy per nucleon and its variation with mass number.

Nature of nuclear forces, nuclear reactions, nuclear fission, nuclear reactors and their uses; nuclear fusion, elementary ideas of energy production in stars.

UNIT 20: Solids and Semiconductor Devices

Energy bands in solids (qualitative ideas only), difference between metals, insulators and semi-conductors using band theory; Intrinsic and extrinsic semi-conductors, p-n junction, Semi-conductor diode-characteristics forward and reverse bias, diode as a rectifier, solar cell, photo-diode, zener diode as a voltage regulator; Junction transistor, characteristics of a transistor; Transistor as an amplifier (common emitter configuration) and oscillator; Logic gates (OR, AND, NOT, NAND, NOR); Elementary ideas about integrated circuits.

UNIT 21: Principles of Communications

Elementary idea of analog and digital communication; Need for modulation, amplitude, frequency and pulse modulation; Elementary ideas about demodulation, Data transmission and retrieval, Fax and Modem. (basic principles)

Space communications - Ground wave, space wave and sky wave propagation, satellite communications, ideas of remote sensing.

Line communications - wire transmission lines, coaxial cables and optical fibres; telephone links, optical fibre communications (qualitative ideas)
