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Physics

Part – I (Senior Secondary Standard)

1. **Physical world and measurement** - Fundamental and derived units, systems of units, dimensional formula and dimensional equations, Accuracy and error in measurement.
2. **Description of motion** - motion in one dimension, uniformly accelerated motion, motion with uniform velocity/Acceleration in two dimensions, motion of an object in three dimensions, relative velocity.
3. **Vectors** - Scalar and vector quantities, unit vector, addition and multiplication.
4. **Laws of motion** - first, second and third law of motion, impulse, momentum, conservation of linear momentum.
5. **Friction** - Types of friction, laws of friction, lubrication.
6. **Work, Energy and Power** - Work done by a constant / variable force, K.E., P.E., Elastic collision in one and two dimensions, gravitational P.E., P.E. of a spring, conservation of energy, conservative and non-conservative forces, power.
7. **Rotational motion** - Centre of mass, its motion, rotational motion, Torque, angular momentum, centripetal force, circular motion, moment of inertia, theorems of M.I., Rolling motion.
8. **Oscillatory motion** - Periodic motion, S.H.M. its equation, K.E. and P.E., concept of free, forced and damped oscillations, simple pendulum, oscillation of a loaded spring.
9. **Gravitation** - Universal law of gravitation, variation of g, orbital and escape velocity, planetary motion, Kepler's law.
10. **Elasticity** - Hook's law, young's modulus, bulk modulus and shear modulus of rigidity. Applications of elastic behaviour of matter.
11. **Surface tension** - Fluid pressure, Pascal's law, Archimedes principle, molecular theory of surface tension, Excess of pressure inside a drop and soap bubble, angle of contact, Capillarity, Detergents.
12. **Liquids in motion** - Type of flow of liquid, Critical velocity, Coefficient of viscosity, Terminal velocity, Stoke's law, Reynold's number, Bernoulli's theorem - its applications.
13. **Kinetic theory of gases** - Laws for gases, Ideal gas equation, Assumptions of Kinetic theory of gases, Pressure exerted by a gas, Law of equipartition of energy, Degree of freedom, Specific heats of gases and solids, Mean free path.
14. **Heat and thermodynamics** - Concept of Heat and temperature, Temp. Scales, Thermal expansion of solid, liquid and gases, specific heat, change of state, latent heat, Thermal capacity, Zeroth & first law of thermodynamics, thermodynamic process, second law of thermodynamics, carnot engine.
15. **Radiation** - Modes of transmission of heat, thermal conductivity, Thermal radiations, Perfect blackbody, Newton's law of cooling.
16. **Waves** - Type of waves, wave equation, speed of a progressive wave, superposition principle, beats, stationary waves and normal modes, Doppler's effect.
17. **Ray optics and optical instruments** - Laws of reflection, Reflection by plane and curved mirrors, Laws of refraction, total internal refraction - applications, Lenses, Image formation by lenses, Dispersion by prism, Scattering of light, Eye, Defects of vision, Microscopes, Telescopes.

18. **Electrostatics** - Coulomb's law, electric field and potential due to a point charge and Dipole, concept of Dielectric, Gauss theorem - its applications, Electric lines of force, Force and torque experience by a dipole in uniform electric field, potential energy of a system of charges, equipotential surfaces.
19. **Capacitance** - Capacity of an isolated spherical conductor, capacitor - principle, Parallel plate capacitors, effect of dielectric on capacitance, series and parallel combinations of Capacitors, Energy of a Capacitor, van de graff generator.
20. **Current Electricity** - Ohm's Law, Temperature dependence of resistance, colour code of resistors, series and parallel combination of resistors, resistivity, primary and secondary cells and their combination in series and parallel, Kirchoff's laws, wheat stone bridge and potentiometer - their applications, electrical energy and power.
21. **Magnetism and magnetic effect of current** - Natural and man made magnet, magnetic lines of force, Bar magnet, magnetism and gauss law, magnetic moment, Torque on a magnetic dipole, magnetic field, magnetic induction, magnetic intensity, permeability, susceptibility & Intensity of magnetisation - their relations. Curie Law, Hysteresis, B-H curve. Classification of magnetic materials. Magnetic force, motion in the magnetic field, Biot - Savarts law, magnetic field by a straight Conductor & Circular Current Carrying Coil, Ampere's Circuital law, Solenoid, Toroid, Moving Coil Galvanometer, Ammeter, Voltmeter.
22. **Electromagnetic Induction** - Faraday's Law, Lenz's Law, Self Induction, Mutual Induction, Electric Generators.
23. **Alternating Current** - Mean and rms value of A.C., A.C. Circuit Containing resistance, Inductance and Capacitance, Series resonant Circuit, Q factor, Average power in A.C., Wattless Current, L C oscillations, transformer.
24. **Wave Optics** - Huygen's principle - reflection and refraction, Interference of light, young's double slit experiment, Diffraction of light, Single slit diffraction, resolving power of optical instruments, polarisation of light, law of malus. Polarization by reflection and scattering.
25. **Photoelectric effect and matter waves** - Einstein's Photoelectric equation, Photocell, matter waves, Debroglie's hypothesis, Davison and Germer's experiment.
26. **Nuclear Physics and Radioactivity** – Nucleus, size, Mass defect, Binding energy, Nuclear fission and fusion, Nuclear reactor, Radioactivity, laws of disintegration, α , β and γ decays.
27. **Solids and semi conductor devices** - Energy band in solids, Semi conductor, P-N Junction, Diodes, Diode as an rectifier, Special purpose p-n junction diodes, Junction transistor, Logic gates, integrated circuit.
28. **Electromagnetic Waves and Communication** – Displacement current, Electromagnetic Waves-Source, nature. Electromagnetic spectrum, Elements of a communication system, Bandwidth of signals and transmission medium, Sky and space wave propagation, Need for modulation, Production and detection of an AM wave.

Part – II (Graduation Standard)

- 1 **MECHANICS:** Inertial frames, Galilean transformation, Non-inertial frames, fictitious forces, rotating co-ordinate systems, Coriolis force and its applications, postulates of special theory of relativity, Lorentz transformations, relativistic addition of velocities, length contraction, time dilation, Variation of mass with velocity, mass energy relation.

System of particles, concept of reduced mass, single stage and multistage rocket, Analysis of collision in centre of mass frame. Angular momentum of a system of particles, equation of motion of a rotating body, inertial coefficients, kinetic energy of rotation and idea of principles axes, Euler's Equations.

Elasticity, relation between elastic constants. Theory of bending of beams and Cantilever, Torsion of a cylinder, Bending moments and Shearing forces.

- 2 **WAVES & OSCILLATIONS:** Potential well and periodic oscillations. Damped harmonic oscillators, Power dissipation, Quality factor, Driven harmonic oscillator, Transient and steady state, Power absorption, Motion of two coupled oscillators, normal modes.
- Waves in media, speed of longitudinal waves in a fluid. energy density and energy transmission in Waves, , Group velocity and phase velocity, their measurements.
- Noise and Music : The human ear and its responses: limits of human audibility. Intensity and loudness, bel and decibel, the musical scale. Temperament and musical instruments. The acoustics of halls. Reverberation period.
- 3 **ELECTROMAGNETISM:** Concept of multi poles, Electrostatic energy of uniformly charged sphere, classical radius of an electron. Screening of E field by a conductor.
- Electric field in matter : atomic and molecular dipoles, , dielectrics, polarisability, polarization vector, electric displacement, electrostatic energy of charge distribution in dielectric, Lorentz local field and Clausius Mossotti equation. Electrostatic field – conductors in electric field, Boundary conditions for potential and field at dielectric surface, uniqueness theorem, Poisson’s and Laplace’s equations in Cartesian cylindrical and spherical polar coordinates, solutions of Laplace’s equations in Cartesian coordinates.
- Maxwell’s equations (integral and differential form) and displacement current. E as an accelerating field: Electron gun, case of discharge tube, linear accelerator, E as deflecting field , CRO.
- 4 **THERMODYNAMICS AND STATISTICAL PHYSICS:** Maxwell velocity distribution, Transport Phenomenon : Mean free path, Coefficients of viscosity, thermal conductivity, diffusion and their interrelation. Clausius-Clapeyron equation, vapor pressure curve. Maxwell relations and their applications.
- Production of low temperatures, Joule Thomson expansion and J.T. coefficients for ideal as well as van der Waals gas, , Temperature inversion, Regenerative cooling, Cooling by adiabatic demagnetization, Liquid Helium, He-I and He-II, Super fluidity, Nernst heat theorem.
- Phase space, Micro and Macro states thermodynamic probability, relation between entropy and thermodynamic probability. Specific heat capacity of solids, Bose Einstein statistics and its distribution function, Planck distribution function and radiation formula, Fermi Dirac statistics and its distribution function.
- 5 **ELECTRONICS and CIRCUIT ANALYSIS :**Four terminal networks : current voltage conventions, open, close and hybrid parameters of any four terminal network, Input, output and mutual independence for an active four terminal network. Various circuits theorems : Superposition, Thevenin, Norton, reciprocity, maximum power transfer Theorems.
- Rectifiers- Half wave, full wave and Bridge rectifier, calculation of ripple factor, efficiency and regulation. Filters, Series inductor shunts capacitor, L section and π section filters. Voltage regulation and voltage stabilization by Zener diode.
- Analysis of transistor amplifiers using hybrid parameters and its gain frequency response. basic idea of R-C coupled amplifiers.
- Transistor biasing - stability factors, various types of bias circuits for thermal bias stability. Amplifier with Feed back : positive and negative feed back. Voltage and current feed back circuits. Advantages of negative feed back.
- Oscillators : Criteria for self excited and self sustained oscillators circuit requirement for build-up of oscillation. Basic transistor oscillator circuit and its analysis; colpitts and Hartley oscillators. R-C Oscillators.
- Junction Field effect transistor (JFET), circuit symbols, biasing and volt-Ampere relations.
- 6 **OPTICS :** Interference of a light, coherence requirements of the sources, optical path retardations, lateral shift of fringes,. thin films, Newton’s ring.. Michelson interferometer. Fabry Perot interferometer and etalon. Fresnel diffraction : Half periods zones, circular aperture, Circular disc, straight edge, Fraunhofer diffraction : double slit, n slit, , Plane diffraction grating, reflection grating, concave grating.
- Lasers and Holography : Spontaneous and stimulated emission, density of states, Einstein’s A and B coefficients, Energy density of radiation as a result of stimulated emission and absorption, Condition for amplification, Population inversion, Methods of optical pumping, Energy level schemes of He-Ne and Ruby lasers, working of a laser source, Special features of a laser source and their origin.

- 7 **QUANTUM MECHANICS AND SPECTROSCOPY:** Failure of classical Physics, Uncertainty principle and its consequences , Application of uncertainty principle.

Schrodinger equation – time dependent and time independent form, Physical significance of the wave function, probability current density, operators in quantum mechanics, Expectation values of dynamical variables, postulates of quantum mechanics, eigen function and eigen value, degeneracy, commutation relations . Ehrenfest theorem.

Time independent Schrodinger equation and stationary state solution, particle in one dimensional box, extension of results for three dimensional case and degeneracy of levels. Potential step and rectangular potential barrier coefficient, square well potential problem. Bound State Problems - Particle in one dimensional infinite potential well and finite depth potential well, simple harmonic oscillator (one dimensional), Schrodinger equation for a spherically symmetric potential, Orbital angular momentum and its quantisation, spherical harmonics, energy levels of H-atom.

Elementary Spectroscopy : Quantum features of one electron atoms, Frank-Hertz experiment, Stern and Gerlach experiment, Spin and Magnetic moment, Spin Orbit coupling and fine structure. Atoms in a magnetic field, Zeeman effect. molecular spectroscopy, Rigid rotator, diatomic molecules, Rotational spectra, Vibrational spectra, Vibrational Rotational spectra,Raman effect.

- 8 **NUCLEAR PHYSICS :** Quadrupole Moment and Nuclear Ellipticity, Nuclear Spin, Parity and Orbital Angular Momentum, Nuclear Mass and Mass Spectroscopy,Proton-Neutron Hypothesis, The Nuclear Potential, Mass Defect and Binding Energy, Nuclear Forces, The Liquid Drop Model.

Accelerators -Linear Accelerators, Cyclotron, Synchrocyclotron, Betatron : The Electromagnetic Induction Accelerator, Electron Synchrotron, Proton Synchrotron.

Particle and Radiation Detectors : Ionisation Chamber, Region of Multiplicative Operation, Proportion Counter, Geiger-Muller Counter, Scintillation counter, Cloud Chamber.

- 9 **SOLID STATE PHYSICS:** Crystal Binding and Crystal Structure: Bravais Lattice, Miller Indices and Crystal Structure, X-ray Diffraction and Bragg's Law, Laue equation of X-ray diffraction.

Thermal Properties of the Solids : Various Theories of Lattice Specific Heat of Solids: The Einstein Model, Debye Model, Electronic Contribution of the internal Energy hence to the Specific Heat of Metals, Thermal Conductivity of the lattice. Band Theory of Solids : Wave Function in a Periodic Lattice and Bloch Theorem, Effective Mass, Momentum, Crystal Momentum .

Electrical Conductivity : Sommerfeld Theory of Electrical Conductivity, Mathiessen's Rule, Thermal Conductivity and Wildemann-Franz's Law, The Hall Effect.

Superconductivity : Experimental Features of Superconductivity, The Isotope Effect, Special Features of Superconducting Materials, Flux Quantisation, BCS Theory of Superconductivity: Cooper Pairs, High Temperature Superconductors (Basic Ideas)

Part – III (Post Graduation Standard)

1. **Mathematical Physics and Classical Mechanics :** Tensors, Matrices, Fourier and Laplace transforms. Bessel and Legendre functions. String formula, basic group theory. D'Alembert's Principle, Lagrangian and Hamiltonian formalism, canonical transformation, Poisson bracket and Poisson theorem, Hamiltonian Principle and Jacobi equation.
2. **Electricity and Magnetism :** Radiation from moving charge and radiation from dipole, concepts of wave guides, Retarded potentials, Lienard-Wiechart potential, Bremsstrahlung and Synchrotron radiation, reaction force of e.m.w.
3. **Thermodynamics and Statistical Physics:** Einstein Statistics, properties of ideal Bose and Fermi Gases, Bose-Einstein condensation. Gibb's paradox, Liouville's theorem, Landau theory of phase transitions. Langevin theory, Fokker-Planck equation.

4. **Quantum Physics:** Elementary theory of scattering in a central potential, partial wave and phase-shift analysis, Identical particle and spin statistics, WKB Method and its applications.
5. **Electronics:** Clipping and clamping circuits of operational amplifiers and its applications, inverting and non-inverting amplifiers, adder, integrator differentiator, Half and Full adder circuits, Flip-Flops, counters and registers.
6. **Atomic, Molecular and Solid State Physics :** Quantum states of an electron in an atom, hydrogen atom spectra, Pauli's Principle, Spin-Orbit interactions, Zeeman effect, Paschen-Back effect, Stark effect, LS and JJ coupling, Hyperfine structure.
Semiconductors statistics of pure and impure semi conductors, Electrical conductivity and its temperature dependence, Recombination mechanisms, Photo conductivity, NMR, ESR and Mossbauer effect.
7. **Nuclear and Particle Physics:** Nuclear shell model, Collective model, Interaction of charged particles and electromagnetic waves with matter. Meson theory of Nuclear force, Nuclear scatter theory: p-p and n-p. Breit-Wigner scattering formula, Fermi theory of β -decay, Gamov theory of α decay.

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