PHYSICS (861)

Aims:

1. To enable candidates to acquire knowledge and to develop an understanding of the terms, facts, concepts, definitions, fundamental laws, principles and processes in the field of physics.
2. To develop the ability to apply the knowledge and understanding of physics to unfamiliar situations.
3. To develop a scientific attitude through the study of physical sciences.
4. To develop skills in -
   (a) the practical aspects of handling apparatus, recording observations and
   (b) drawing diagrams, graphs, etc.
5. To develop an appreciation of the contribution of physics towards scientific and technological developments and towards human happiness.
6. To develop an interest in the world of physical sciences.

CLASS XI

There will be two papers in the subject.

***Paper I**: Theory - 3 hour ... 70 marks*

***Paper II**: Practical - 3 hours ... 20 marks*

Project Work … 7 marks

Practical File … 3 marks

PAPER I -THEORY – 70 Marks

Paper I shall be of 3 hours duration and be divided into two parts.

***Part I (20 marks):** This part will consist of compulsory short answer questions, testing knowledge, application and skills relating to elementary/fundamental aspects of the entire syllabus.*

***Part II (50 marks):** This part will be divided into three Sections A, B and C. There shall be **six** questions in Section A (each carrying 7 marks) and candidates are required to answer **four** questions from this Section. There shall be **three** questions in Section B (each carrying 6 marks) and candidates are required to answer **two** questions from this Section. There shall be **three** questions in Section C (each carrying 5 marks) and candidates are required to answer **two** questions from this Section. Therefore, candidates are expected to answer **eight** questions in Part II.*

***Note:** Unless otherwise specified, only S. I. Units are to be used while teaching and learning, as well as for answering questions.*

SECTION A

1. Role of Physics

(i) Scope of Physics.

Applications of Physics to everyday life. Inter-relation with other science disciplines. Physics learning and phenomena of nature; development of spirit of inquiry, observation, measurement, analysis of data, interpretation of data and scientific temper; appreciation for the beauty of scheme of nature.

(ii) Role of Physics in technology.

Physics as the foundation of all technical advances - examples. Quantitative approach of physics as the beginning of technology. Technology as the extension of applied physics. Growth of technology made possible by advances in physics. Fundamental laws of nature are from physics. Technology is built on the basic laws of physics.

(iii) Impact on society.

Effect of discoveries of laws of nature on the philosophy and culture of people. Effect of growth of physics on our understanding of natural phenomenon like lighting and thunder, weather changes, rain, etc. Effect of study of quantum mechanics, dual nature of matter, nuclear physics and astronomy on the macroscopic and microscopic picture of our universe.

2. Units

(i) SI units. Fundamental and derived units (correct symbols for units including conventions for symbols).

Importance of measurement in scientific studies; physics is a science of measurement. Unit as a reference standard of measurement; essential properties. Systems of unit; CGS, FPS, MKSA, and SI; the seven base units of SI selected by the General Conference of Weights and Measures in 1971 and their definitions; list of fundamental physical quantities; their units and symbols, strictly as per rule; subunits and multiple units using prefixes for powers of 10 (from atto for 10^{-18} to tera for 10^{12}); other common units such as fermi, angstrom (now outdated), light year, astronomical unit and parsec. A new unit of mass used in atomic physics is unified atomic mass unit with symbol u (not amu); rules for writing the names of units and their symbols in SI (upper case/lower case, no period after symbols, etc.)

Derived units (with correct symbols); special names wherever applicable; expression in terms of base units (eg: $N= kgm/s^2$).

(ii) Accuracy and errors in measurement, least count of measuring instruments (and the implications for errors in experimental measurements and calculations).

Accuracy of measurement, errors in measurement: instrumental errors, systematic errors, random errors and gross errors. Least count of an instrument and its implication for errors in measurements; absolute error, relative error and percentage error; combination of error in (a) sum and difference, (b) product and quotient and (c) power of a measured quantity.

(iii) Significant figures and order of accuracy with reference to measuring instruments. Powers of 10 and order of magnitude.

What are significant figures? Their significance; rules for counting the number of significant figures; rules for (a) addition and subtraction, (b) multiplication/division; 'rounding off' the uncertain digits; order of magnitude as statement of magnitudes in powers of 10; examples from magnitudes of common physical quantities - size, mass, time, etc.

3. Dimensions

(i) Dimensional formula of physical quantities and physical constants like g, h, etc. (from Mechanics only).

Dimensions of physical quantities; dimensional formula; express derived units in terms of base units ($N = kg.ms^{-2}$); use symbol [...] for dimension of or base unit of; ex: dimensional formula of force in terms of base units is written as $[F]=[MLT^{-2}]$. Expressions in terms of SI base units may be obtained for all physical quantities as and when new physical quantities are introduced.

(ii) Dimensional equation and its use to check correctness of a formula, to find the relation between physical quantities, to find the dimension of a physical quantity or constant; limitations of dimensional analysis.

Use of dimensional analysis to (i) check the dimensional correctness of a formula/ equation, (ii) to obtain the exact dependence of a physical quantity on other mechanical variables, and (iii) to obtain the dimensional formula of any derived physical quantity including constants; limitations of dimensional analysis.

4. Vectors, Scalar Quantities and Elementary Calculus

(i) Vectors in one dimension, two dimensions and three dimensions, equality of vectors and null vector.

Vectors explained using displacement as a prototype - along a straight line (one dimension), on a plane surface (two dimension) and in open space not confined to a line or plane (three dimension); symbol and representation; a scalar quantity, its representation and unit, equality of vectors. Unit vectors denoted by $\hat{i}$, $\hat{j}$, $\hat{k}$ orthogonal unit vectors along x, y and z axes respectively. Examples of one dimensional vector $\vec{V}_1 = a\hat{i}$ or $b\hat{j}$ or $c\hat{k}$ where a, b, c are scalar quantities or numbers; $\vec{V}_2 = a\hat{i} + b\hat{j}$ is a two dimensional vector, $\vec{V}_3 = a\hat{i} + b\hat{j} + c\hat{k}$ is a three dimensional vector. Define and discuss the need of a null vector. Concept of co-planar vectors.

(ii) Vector operations (addition, subtraction and multiplication of vectors including use of unit vectors $\hat{i}, \hat{j}, \hat{k}$); parallelogram and triangle law of vector addition.

Addition: use displacement as an example; obtain triangle law of addition; graphical and analytical treatment; Discuss commutative and associative properties of vector addition (Proof not required). Parallelogram Law; sum and difference; derive expression for magnitude and directions from a parallelogram; special cases; subtraction as special case of addition with direction reversed; use of Triangle Law for subtraction also; if $\vec{a} + \vec{b} = \vec{c}$; $\vec{c} - \vec{a} = \vec{b}$; *In a parallelogram, if one diagonal is the sum, the other diagonal is the difference; addition and subtraction with vectors expressed in terms of unit vectors* $\hat{i}, \hat{j}, \hat{k}$ *; multiplication of a vector by real numbers.*

(iii) Resolution and components of like vectors in a plane (including rectangular components), scalar (dot) and vector (cross) products.

Use triangle law of addition to express a vector in terms of its components. If $\vec{a} + \vec{b} = \vec{c}$ *is an addition fact,* $\vec{c} = \vec{a} + \vec{b}$ *is a resolution;* $\vec{a}$ *and* $\vec{b}$ *are components of* $\vec{c}$. *Rectangular components, relation between components, resultant and angle in between. Dot (or scalar) product of vectors or scalar product* $\vec{a} \cdot \vec{b} = ab\cos\theta$*; example* $W = \vec{F} \cdot \vec{S}$ *Special case of* $\theta = 0, 90$ *and* 180^0. *Vector (or cross) product* $\vec{a} \times \vec{b} = [ab\sin\theta]\hat{n}$ *; example: torque* $\vec{\tau} = \vec{r} \times \vec{F}$ *; Special cases using unit vectors* $\hat{i}, \hat{j}, \hat{k}$ *for* $\vec{a} \cdot \vec{b}$ *and* $\vec{a} \times \vec{b}$.

[Elementary Calculus: differentiation and integration as required for physics topics in Classes XI and XII. No direct question will be asked from this subunit in the examination].

Differentiation as rate of change; examples from physics – speed, acceleration, etc. Formulae for differentiation of simple functions: x^n, *sinx, cosx,* e^x *and ln x. Simple ideas about integration – mainly.* $\int x^n.dx$. *Both definite and indefinite integral should be explained.*

5. Dynamics

(i) Cases of uniform velocity, equations of uniformly accelerated motion and applications including motion under gravity (close to surface of the earth) and motion along a smooth inclined plane.

Review of rest and motion; distance and displacement, speed and velocity, average speed and average velocity, uniform velocity, instantaneous speed and instantaneous velocity, acceleration, instantaneous acceleration, s-t, v-t and a-t graphs for uniform acceleration and discussion of useful information obtained from the graphs; kinematic equations of motion for objects in uniformly accelerated rectilinear motion derived using calculus or otherwise, motion of an object under gravity, (one dimensional motion). Acceleration of an object moving up and down a smooth inclined plane.

(ii) Relative velocity, projectile motion.

Start from simple examples on relative velocity of one dimensional motion and then two dimensional motion; consider displacement first; relative displacement (use Triangle Law); $\vec{S}_{AB} = \vec{S}_A - \vec{S}_B$ *then differentiating we get* $\vec{v}_{AB} = \vec{v}_A - \vec{v}_B$ *; projectile motion; Equation of trajectory; obtain equations for max. height, velocity, range, time of flight, etc; relation between horizontal range and vertical range [projectile motion on an inclined plane not included]. Examples and problems on projectile motion.*

(iii) Newton's laws of motion and simple applications. Elementary ideas on inertial and uniformly accelerated frames of reference.

[Already done in Classes IX and X, so here it can be treated at higher maths level using vectors and calculus].

Newton's first law: Statement and explanation; inertia, mass, force definitions; law of inertia; mathematically, if $\sum F=0$, $a=0$.

Newton's second law: $\vec{p} = m\vec{v}$; $\vec{F} \alpha \dfrac{d\vec{p}}{dt}$; $\vec{F} = k \dfrac{d\vec{p}}{dt}$. *Define unit of force so that* *k=1;* $\vec{F} = \dfrac{d\vec{p}}{dt}$*; a vector equation. For classical physics with v not large and mass m remaining constant, obtain* $\vec{F} = m\vec{a}$*. For* $v \rightarrow c$*, m is not constant. Then* $m = m_0 / \sqrt{1 - v^2/c^2}$*. Note that F= ma is the special case for classical mechanics. It is a vector equation.* $\vec{a} \parallel \vec{F}$*. Also, this can be resolved into three scalar equations* $F_x = ma_x$ *etc. Application to numerical problems; introduce tension force, normal reaction force. If a = 0 (body in equilibrium), F= 0. Impulse* $F\Delta t = \Delta p$*; unit; problems.*

Newton's third law. Simple ideas with examples of inertial and uniformly accelerated frames of reference. Simple applications of Newton's laws: tension, normal reaction; law of conservation of momentum. Systematic solution of problems in mechanics; isolate a part of a system, identify all forces acting on it; draw a free body diagram representing the part as a point and representing all forces by line segments, solve for resultant force which is equal to $m\vec{a}$*. Simple problems on "Connected bodies" (not involving two pulleys).*

(iv) Concurrent forces (reference should be made to force diagrams and to the point of application of forces), work done by constant and variable force (Spring force).

Force diagrams; resultant or net force from law of Triangle of Forces, parallelogram law or resolution of forces. Apply net force $\Sigma\vec{F} = m\vec{a}$*. Again for equilibrium a=0 and* $\Sigma F=0$*. Conditions of equilibrium of a rigid body under three coplanar forces. Discuss ladder problem. Work done* $W = \vec{F}\cdot\vec{S} = FS\cos\theta$*. If F is variable* $dW = \vec{F}\cdot d\vec{S}$ *and* $W = \int dw = \int \vec{F}\cdot d\vec{S}$*, for* $\vec{F} \parallel d\vec{S}$ $\vec{F}\cdot d\vec{S} = FdS$ *therefore,* $W = \int FdS$ *is the area under the F-S graph or if F can be expressed in terms of S,* $\int FdS$ *can be evaluated. Example, work done in stretching a spring* $W = \int Fdx = \int kxdx = \frac{1}{2}kx^2$*. This is also the potential energy stored in the stretched spring* $U = \frac{1}{2}kx^2$*.*

(v) Energy, conservation of energy, power, conservation of linear momentum, impulse, elastic and inelastic collisions in one and two dimensions.

E=W. Units same as that of work W; law of conservation of energy; oscillating spring. $U+K = E = K_{max} = U_{max}$ *(for U = 0 and K = 0 respectively); different forms of energy* $E = mc^2$*; no derivation. Power P=W/t; units;* $P = \vec{F}\cdot\vec{v}$*; conservation of linear momentum (done under Newton's 3rd law); impulse Ft or* $F\Delta t$*. unit N.s and joule- done under 2nd law. Collision in one dimension; derivation of velocity equation for general case of* $m_1 \neq m_2$ *and* $u_1 \neq u_2 = 0$*; Special cases for* $m_1 = m_2 = m$*;* $m_1 >> m_2$ *or* $m_1 << m_2$*. Oblique collisions i.e. collision in two dimensions.*

6. Friction

(i) Friction in solids: static; sliding; rolling.

Static friction, a self-adjusting force; limiting value; kinetic friction or sliding friction; rolling friction, examples.

(ii) Laws of friction. Co-efficient of friction.

Laws of friction: Two laws of static friction; (similar) two laws of kinetic friction; coefficient of friction $\mu_s = f_s(max)/N$ *and* $\mu_k = f_k/N$*; Friction as a non conservative force; motion under friction, net force in Newton's 2nd law is calculated including* f_k*; numerical problems applying laws of friction and Newton's second law of motion. Motion along a rough inclined plane – both up and down. Pulling and pushing of a roller. Angle of friction and angle of repose.*

7. Motion in Fluids

(i) Equation of continuity of fluid flow and its application, buoyancy, Bernoulli's principle, (venturimeter, pitot tube, atomizer, dynamic uplift). Pressure in a fluid, Pascal's law.

General characteristics of fluid flow; equation of continuity $v_1a_1 = v_2a_2$*; conditions; applications like use of nozzle at the end of a hose; buoyancy; Bernoulli's principle* *(theorem); assumptions - incompressible liquid, streamline (steady) flow, non-viscous and irrotational liquid - ideal liquid; derivation of equation; applications of Bernoulli's theorem as given in the syllabus. Discuss in brief: Pressure in a fluid, Pascal's law.*

(ii) Stream line and turbulent flow, Reynold's number (derivation not required).

Streamline and turbulent flow - examples; trajectory of fluid particles; streamlines do not intersect (like electric and magnetic lines of force); tubes of flow; number of streamlines per unit area α velocity of flow (from equation of continuity $v_1a_1 = v_2a_2$); critical velocity; Reynold's number - no derivation, but check dimensional correctness. (Poisseulle's formula excluded).

(iii) Viscous drag; Newton's formula for viscosity, co-efficient of viscosity and its units.

Flow of fluids (liquids and gases), laminar flow, internal friction between layers of fluid, between fluid and the solid with which the fluid is in relative motion; examples; viscous drag is a force of friction; mobile and viscous liquids.

Velocity gradient dv/dx (space rate of change of velocity); viscous drag $F = \eta A\ dv/dx$; coefficient of viscosity $\eta = F/A(dv/dx)$ depends on the nature of the liquid and its temperature; units: Ns/m^2 and $dyn.s/cm^2$= poise. 1 poise=0.1 Ns/m^2; value of η for a few selected fluids.

(iv) Stoke's law, terminal velocity of a sphere falling through a fluid or a hollow rigid sphere rising to the surface of a fluid.

Motion of a sphere falling through a fluid, hollow rigid sphere rising to the surface of a liquid, parachute, terminal velocity; forces acting; buoyancy (Archimedes principle); viscous drag, a force proportional to velocity; Stoke's law; v-t graph.

8. Circular Motion

(i) Centripetal acceleration and force, motion round a banked track, point mass at the end of a light inextensible string moving in (i) horizontal circle (ii) vertical circle and a conical pendulum.

Definition of centripetal acceleration; derive expression for this acceleration using Triangle Law to find $\Delta\vec{v}$. Magnitude and direction of $\bar{a}$ same as that of $\Delta\vec{v}$; Centripetal acceleration; the cause of this acceleration is a force - also called centripetal force; the name only indicates its direction, it is not a new type of force, it could be mechanical tension as in motion of a point mass at the end of a light inextensible string moving in a circle, or electric as on an electron in Bohr model of atom, or magnetic as on any charged particle moving in a magnetic field [may not introduce centrifugal force]; conical pendulum, formula for centripetal force and tension in the string; motion in a vertical circle; banking of road and railway track.

(ii) Centre of mass, moment of inertia: rectangular rod; disc; ring; sphere.

Definition of centre of mass (cm) for a two particle system moving in one dimension $m_1x_1+m_2x_2=Mx_{cm}$; differentiating, get the equation for v_{cm} and a_{cm}; general equation for N particles- many particles system; [need not go into more details]; concept of a rigid body; kinetic energy of a rigid body rotating about a fixed axis in terms of that of the particles of the body; hence define moment of inertia and radius of gyration; unit and dimensions; depend on mass and axis of rotation; it is rotational inertia; applications: derive expression for the moment of inertia, I (about the symmetry axis) of (i) a particle rotating in a circle (e.g. electron in Bohr model of H atom); (ii) a ring; also I of a thin rod, a solid and hollow sphere, a ring, a disc and a hollow cylinder - only formulae (no derivation).

(iii) Parallel axis theorem and perpendicular axis theorem; radius of gyration.

Statement of the theorems with illustrations [derivation not required]. Simple applications to the cases derived under 8(ii), with change of axis.

(iv) Torque and angular momentum, relation between torque and moment of inertia and between angular momentum and moment of inertia; conservation of angular momentum and applications.

Definition of torque (vector); $\vec{\tau} = \vec{r} \times \vec{F}$ and angular momentum $\vec{l} = \vec{r} \times \vec{p}$ for a particle; differentiate to obtain $d\vec{l}/dt = \vec{\tau}$; similar to Newton's second law of motion (linear); angular velocity $\omega = v/r$ and angular acceleration $\alpha = a/r$, hence $\tau = I\alpha$ and $l = I\omega$; (only scalar equation); Law of conservation of angular momentum; simple applications.

9. Gravitation

(i) Newton's law of universal gravitation; gravitational constant (G); gravitational acceleration on surface of the earth (g).

Statement; unit and dimensional formula of universal gravitational constant, G [Cavendish experiment not required]; weight of a body W= mg from F=ma.

(ii) Relation between G and g; variation of gravitational acceleration above and below the surface of the earth.

From the Newton's Law of Gravitation and Second Law of Motion $g = Gm/R^2$ applied to earth. Variation of g above and below the surface of the earth; graph; mention variation of g with latitude and rotation, (without derivation).

(iii) Gravitational field, its range, potential, potential energy and intensity.

Define gravitational field, intensity of gravitational field and potential at a point in earth's gravitational field. $V_p = W_{\alpha p}/m_o$. Derive the expression (by integration) for the gravitational potential difference $\Delta V = V_B - V_A = G.M(1/r_A - 1/r_B)$; here $V_p = V(r) = -GM/r$; negative sign for attractive force field; define gravitational potential energy of a mass m in the earth's field; obtain expression for gravitational potential energy $U(r) = W_{\alpha p} = m.V(r) = -G\,M\,m/r$; show that for a not so large change in distance $\Delta U = mgh$. Relation between intensity and acceleration due to gravity. Compare its range with those of electric, magnetic and nuclear fields.

(iv) Escape velocity (with special reference to the earth and the moon); orbital velocity and period of a satellite in circular orbit (particularly around the earth).

Define and obtain expression for the escape velocity from earth using energy consideration; v_e depends on mass of the earth; from moon v_e is less as mass of moon is less; consequence - no atmosphere on the moon; satellites (both natural (moon) and artificial satellite) in uniform circular motion around the earth; orbital velocity and time period; note the centripetal acceleration is caused (or centripetal force is provided) by the force of gravity exerted by the earth on the satellite; the acceleration of the satellite is the acceleration due to gravity [$g' = g(R/R+h)^2$; $F'_G = mg'$].

(v) Geostationary satellites - uses of communication satellites.

Conditions for satellite to be geostationary. Uses.

(vi) Kepler's laws of planetary motion.

Explain the three laws using diagrams. Proof of second and third law (circular orbits only); derive only $T^2 \alpha R^3$ from 3rd law for circular orbits.

SECTION B

10. Properties of Matter - Temperature

(i) Properties of matter: Solids: elasticity in solids, Hooke's law, Young modulus and its determination, bulk modulus and modulus of rigidity, work done in stretching a wire. Liquids: surface tension (molecular theory), drops and bubbles, angle of contact, work done in stretching a surface and surface energy, capillary rise, measurement of surface tension by capillary rise methods. Gases: kinetic theory of gases: postulates, molecular speeds and derivation of $p = ⅓\,\rho\overline{c^2}$, equation of state of an ideal gas pV = nRT (numerical problems not included from gas laws).

For solids and liquids; the scope as given above is clear. For gases; derive $p = 1/3\,\rho\overline{c^2}$ from the assumptions and applying Newton's laws of motion. The average thermal velocity (rms value) $c_{rms} = \sqrt{3p/\rho}$; calculate for air, hydrogen and their comparison with common speeds of transportation. Effect of temperature and pressure on rms speed of gas molecules. [Note that pV=nRT the ideal gas *equation cannot be derived from kinetic theory of ideal gas. Hence, neither can other gas laws; pV=nRT is an experimental result. Comparing this with* $p = \frac{1}{3}\rho \overline{c^2}$ *, from kinetic theory of gas a kinetic interpretation of temperature can be obtained as explained in the next subunit].*

(ii) Temperature: kinetic interpretation of temperature (relation between $\overline{c^2}$ and T); absolute temperature. Law of equipartition of energy (statement only).

From kinetic theory for an ideal gas (obeying all the assumptions especially no intermolecular attraction and negligibly small size of molecules, we get $p = (1/3)\rho\,\overline{c^2}$ *or* $pV = (1/3)M\overline{c^2}$ *. (No further, as temperature is not a concept of kinetic theory). From experimentally obtained gas laws we have the ideal gas equation (obeyed by some gases at low pressure and high temperature) pV = RT for one mole. Combining these two results (assuming they can be combined),* $RT=(1/3)M\overline{c^2} =(2/3).\frac{1}{2}M\overline{c^2} =(2/3)K$*; Hence, kinetic energy of 1 mole of an ideal gas K=(3/2)RT. Average K for 1 molecule = K/N = (3/2) RT/N = (3/2) kT where k is Boltzmann's constant. So, temperature T can be interpreted as a measure of the average kinetic energy of the molecules of a gas. Degrees of freedom, statement of the law of equipartition of energy. Scales of temperature - only Celsius, Fahrenheit and Kelvin scales.*

11. Internal Energy

(i) First law of thermodynamics.

Review the concept of heat (Q) as the energy that is transferred (due to temperature difference only) and not stored; the energy that is stored in a body or system as potential and kinetic energy is called internal energy (U). Internal energy is a state property (only elementary ideas) whereas, heat is not; first law is a statement of conservation of energy, when, in general, heat (Q) is transferred to a body (system), internal energy (U) of the system changes and some work W is done by the system; then $Q=\Delta U+W$*; also* $W=\int pdV$ *for working substance an ideal gas; explain the meaning of symbols (with examples) and sign convention carefully (as used in physics:* $Q>0$ *when to a system,* $\Delta U>0$ *when U increases or temperature rises, and* $W>0$ *when work is done by the system). Special cases for Q=0 (adiabatic),* $\Delta U=0$ *(isothermal) and W=0 (isochoric).*

(ii) Isothermal and adiabatic changes in a perfect gas described in terms of curves for PV = constant and PV^γ = constant; joule and calorie relation (derivation for PV^γ = constant not included).

Self-explanatory. Note that 1 cal = 4·186 J exactly and J (so-called mechanical equivalent of heat) should not be used in equations. In equations, it is understood that each term as well as the LHS and RHS are in the same units; it could be all joules or all calories.

(iii) Work done in isothermal and adiabatic expansion; principal molar heat capacities; C_p and C_v; relation between C_p and C_v ($C_p - C_v = R$). C_p and C_v for monatomic and diatomic gasses.

Self-explanatory. Derive the relations.

Work done as area bounded by PV graph.

(iv) Second law of thermodynamics, Carnot's cycle. Some practical applications.

Only one statement each in terms of Kelvin's impossible steam engine and Clausius' impossible refrigerator. Brief explanation of law. Carnot's cycle - describe realisation from source and sink of infinite thermal capacity, thermal insulation, etc. Explain pV graph (isothermal and adiabatic of proper slope); obtain expression for efficiency $\eta=1-T_2/T_1$*. Understanding ways of enhancing efficiency of a device – energy saving devices like C.F.L., designing buildings that make the best use of natural light and suits the local climatic conditions. LED's – save not only energy, but also help in reducing global warming.*

(v) Thermal conductivity; co-efficient of thermal conductivity, Use of good and poor conductors, Searle's experiment. [Lee's Disc method is not required]. comparison of thermal and electrical conductivity. Convection with examples.

Define coefficient of thermal conductivity from the equation for heat flow $Q = KA\ d\theta/dt$; temperature gradient; Comparison of thermal and electrical conductivities (briefly). Examples of convection.

(vi) Thermal radiation: nature and properties of thermal radiation, qualitative effects of nature of surface on energy absorbed or emitted by it; black body and black body radiation, Stefan's law (using Stefan's law to determine the surface temperature of the sun or a star by treating it as a black body); Newton's law of cooling, Wien's displacement law, distribution of energy in the spectrum of black body radiation (only qualitative and graphical treatment).

Black body is now called ideal or cavity radiator and black body radiation is cavity radiation; Stefan's law is now known as Stefan Boltzmann law as Boltzmann derived it theoretically. There is multiplicity of technical terms related to thermal radiation - radiant intensity I (T) for total radiant power (energy radiated/second) per unit area of the surface, in W/m^2, $I(T) = \sigma T^4$; dimensions and SI unit of σ. For practical radiators $I = \in. \sigma T^4$ where $\in$ (dimension less) is called emmissivity of the surface material; $\in=1$ for ideal radiators. The Spectral radiancy $R(\lambda)$. $I(T)=\int_0^{\alpha} R(\lambda)\, d\lambda$. Graph of $R(\lambda)$ vs λ for different temperatures. Area under the graph is I (T). The λ corresponding to maximum value of R is called λ_{max}; decreases with increase in temperature.

$\lambda_{max}\ \alpha\ 1/T$; $\lambda_m.T=2898\mu m.K$ - Wein's displacement law; application to determine temperature of stars, numerical problems. From known temperature, we get $I(T)= \sigma T^4$. The luminosity (L) of a star is the total power radiated in all directions $L=4\pi r^2.I$ from the solar radiant power received per unit area of the surface of the earth (at noon), the distance of the sun and the radius of the sun itself, one can calculate the radiant intensity I of the sun and hence the temperature T of its surface using Stefan's law. Numerical problems. Cover Newton's law of cooling briefly, numerical problems to be covered. [Deductions from Stefan's law not necessary]. Developing technologies that do not harm the environment – Solar Cooker and Solar Cars, etc.

SECTION C

12. Oscillations

(i) Simple harmonic motion.

(ii) Expressions for displacement, velocity and acceleration.

(iii) Characteristics of simple harmonic motion.

(iv) Relation between linear simple harmonic motion and uniform circular motion.

(v) Kinetic and potential energy at a point in simple harmonic motion.

(vi) Derivation of time period of simple harmonic motion of a simple pendulum, mass on a spring (horizontal and vertical oscillations).

Periodic motion, period T and frequency f, $f=1/T$; uniform circular motion and its projection on a diameter defines SHM; displacement, amplitude, phase and epoch velocity, acceleration, time period; characteristics of SHM; differential equation of SHM, $d^2y/dt^2+\omega^2y=0$ from the nature of force acting $F=-k\ y$; solution $y=A \sin(\omega t+\phi_0)$ where $\omega^2 = k/m$; expression for time period T and frequency f. Examples, simple pendulum, a mass m attached to a spring of spring constant k. Total energy $E = U+K$ (potential +kinetic) is conserved. Draw graphs of U, K and E Vs y.

(vii) Free, forced and damped oscillations (qualitative treatment only). Resonance.

Examples of damped oscillations (all oscillations are damped); graph of amplitude vs time for undamped and damped oscillations; damping force (-bv) in addition to restoring force (-ky); forced oscillations, examples; action of an external periodic force, in addition to restoring force. Time period is changed to that of the external applied force, amplitude (A) varies with frequency of the applied force and it is *maximum when the f of the external applied force is equal to the natural frequency of the vibrating body. This is resonance; maximum energy transfer from one body to the other; bell graph of amplitude vs frequency of the applied force. Examples from mechanics, electricity and electronics (radio).*

13. Waves

(i) Transverse and longitudinal waves; relation between speed, wavelength and frequency; expression for displacement in wave motion; characteristics of a harmonic wave; graphical representation of a harmonic wave; amplitude and intensity.

Review wave motion covered in Class IX. Distinction between transverse and longitudinal waves; examples; define displacement, amplitude, time period, frequency, wavelength and derive $v=f\lambda$; graph of displacement with time/position, label time period/wavelength and amplitude, equation of a progressive harmonic (sinusoidal) wave, $y = A \sin (kx-\omega t)$; amplitude and intensity.

(ii) Sound as a wave motion, Newton's formula for the speed of sound and Laplace's correction; variation in the speed of sound with changes in pressure, temperature and humidity; speed of sound in liquids and solids (descriptive treatment only).

Review of production and propagation of sound as wave motion; mechanical wave requires a medium; general formula for speed of sound (no derivation). Newton's formula for speed of sound in air; experimental value; Laplace's correction; calculation of value at STP; numerical problems; variation of speed v with changes in pressure, density, humidity and temperature. Speed of sound in liquids and solids - brief introduction only. Some values. Mention the unit Mach 1, 2, etc. Concept of supersonic and ultrasonic.

(iii) Superimposition of waves (interference, beats and standing waves), progressive and stationary waves.

The principle of superposition; interference (simple ideas only); dependence of combined wave form, on the relative phase of the interfering waves; qualitative only - illustrate with wave representations. Beats (qualitative explanation only); number of beats produced per second = difference in the frequencies of the interfering waves; numerical problems. Standing waves or stationary waves; formation by two traveling waves (of λ and f same) traveling in opposite directions (ex: along a string, in an air column - incident and reflected waves); obtain $y= y_1+y_2= [2 y_m \sin kx] \cos(\omega t)$ using equations of the traveling waves; variation of the amplitude $A=2 y_m \sin kx$ with location (x) of the particle; nodes and antinodes; compare standing waves with progressive waves.

(iv) Laws of vibrations of stretched strings.

Equation for fundamental frequency $f_0=(½l)\sqrt{T/m}$; sonometer, experimental verification.

(v) Modes of vibration of strings and air columns; resonance.

Vibrations of strings and air column (closed and open pipe); standing waves with nodes and antinodes; also in resonance with the periodic force exerted usually by a tuning fork; sketches of various nodes; fundamental and overtones-harmonics; mutual relation.

(vi) Doppler Effect for sound.

Doppler effect for sound; general expression for the Doppler effect when both the source and listener are moving can be given by $f_L = f_r\left(\frac{v \pm v_L}{v \pm v_r}\right)$ which can be reduced to any one of the four special cases, by applying proper sign convention.

(vii) Noise

Sound as noise, some major sources of noise like construction sites, generators in residential units/institutions, airports, industrial grinders. Effect of noise on people working in such places and neighbouring communities.

***NOTE:** Numerical problems are included from all topics except where they are specifically excluded or where only qualitative treatment is required.*

PAPER II

PRACTICAL WORK- 20 Marks

The following experiments are recommended for practical work. In each experiment, students are expected to record their observations in tabular form with units at the column head. Students should plot an appropriate graph, work out the necessary calculations and arrive at the result. The teacher may alter or add.

1. Measurement by Vernier callipers. Measure the diameter of a spherical body. Calculate the volume with appropriate significant figures. Measure the volume using a graduated cylinder and compare it with calculated value.
2. Find the diameter of a wire using a micrometer screw gauge and determine percentage error in cross sectional area.
3. Determine radius of curvature of a spherical surface like watch glass by a spherometer.
4. Equilibrium of three concurrent coplanar forces. To verify the parallelogram law of forces and to determine weight of a body.
5. Inclined plane: To find the downward force acting along the inclined plane on a roller due to gravitational pull of earth and to study its relationship with angle of inclination by plotting graph between force and sin θ.
6. Friction: To find the force of kinetic friction for a wooden block placed on horizontal surface and to study its relationship with normal reaction. To determine the coefficient of friction.
7. To find the acceleration due to gravity by measuring the variation in time period (T) with effective length (L) of simple pendulum; plot graph of T vs $\sqrt{L}$ and T^2 vs L.
8. To find the force constant of a spring and to study variation in time period of oscillation of a body suspended by the spring. To find acceleration due to gravity by plotting graph of T against $\sqrt{m}$.
9. Oscillation of a simple meter rule used as bar pendulum. To study variation in time period (T) with distance of centre of gravity from axis of suspension and to find radius of gyration and moment of inertia about an axis through the centre of gravity.
10. Boyle's Law: To study the variation in volume with pressure for a sample of air at constant temperature by plotting graphs between p and $^1/_V$ and between p and V.
11. Cooling curve: To study the fall in temperature of a body (like hot water or liquid in calorimeter) with time. Find the slope of curve at four different temperatures of hot body and hence deduce Newton's law of cooling.
12. Determine Young's modulus of elasticity using Searle's apparatus.
13. To study the variation in frequency of air column with length using resonance column apparatus or a long cylinder and set of tuning forks. Hence determine velocity of sound in air at room temperature.
14. To determine frequency of a tuning fork using a sonometer.
15. To verify laws of vibration of strings using a sonometer.
16. To determine the surface tension of water by capillary rise method.
17. To determine the coefficient of viscosity of a given viscous liquid by measuring terminal velocity of a given spherical body.

PROJECT WORK AND PRACTICAL FILE – 10 Marks

Project Work – 7 Marks

All candidates will do project work involving some Physics related topics, under the guidance and regular supervision of the Physics teacher. Candidates are to prepare a technical report formally written including an abstract, some theoretical discussion, experimental setup, observations with tables of data collected, analysis and discussion of results, deductions, conclusion, etc. (after the draft has been approved by the teacher). The report should be kept simple, but neat and elegant. No extra credit shall be given for type-written material/decorative cover, etc. Teachers may assign or students may choose any one project of their choice.

Practical File – 3 Marks

Teachers are required to assess students on the basis of the Physics practical file maintained by them during the academic year.

CLASS XII

There will be two papers in the subject.

***Paper I**: Theory - 3 hour ... 70 marks*

***Paper II**: Practical - 3 hours ... 20 marks*

Project Work ... 7 marks

Practical File ... 3 marks

PAPER I -THEORY- 70 Marks

Paper I shall be of 3 hours duration and be divided into two parts.

***Part I (20 marks):** This part will consist of compulsory short answer questions, testing knowledge, application and skills relating to elementary/fundamental aspects of the entire syllabus.*

***Part II (50 marks):** This part will be divided into three Sections A, B and C. There shall be **three** questions in Section A (each carrying 9 marks) and candidates are required to answer **two** questions from this Section. There shall be **three** questions in Section B (each carrying 8 marks) and candidates are required to answer **two** questions from this Section. There shall be **three** questions in Section C (each carrying 8 marks) and candidates are required to answer **two** questions from this Section. Therefore, candidates are expected to answer **six** questions in Part II.*

***Note:** Unless otherwise specified, only S. I. units are to be used while teaching and learning, as well as for answering questions.*

SECTION A

1. Electrostatics

(i) Coulomb's law, S.I. unit of charge; permittivity of free space.

Review of electrostatics covered in Class X. Frictional electricity, electric charge (two types); repulsion and attraction; simple atomic structure - electrons and protons as electric charge carriers; conductors, insulators; quantisation of electric charge; conservation of charge; Coulomb's law (in free space only); vector form; (position coordinates r_1, r_2 not necessary); SI unit of charge; Superposition principle; simple numerical problems.

(ii) Concept of electric field $E = F/q_o$; Gauss' theorem and its applications.

Action at a distance versus field concept; examples of different fields; temperature and pressure (scalar); gravitational, electric and magnetic (vector field); definition $\vec{E} = \vec{F} / q_o$.

Electric field due to a point charge; $\vec{E}$ for a group of charges (superposition); A point charge q in an electric field $\vec{E}$ experiences an electric force $\vec{F}_E = q\vec{E}$.

Gauss' theorem: the flux of a vector field; Q=VA for velocity vector $\vec{V} \parallel \vec{A}$, the area vector, for uniform flow of a liquid. Similarly for electric field $\vec{E}$, electric flux $\phi_E = EA$ for $\vec{E} \parallel \vec{A}$ and $\phi_E = \vec{E} \cdot \vec{A}$ for uniform $\vec{E}$. For non-uniform field $\phi_E = \int d\phi = \int \vec{E}.d\vec{A}$. Special cases for $\theta = 0°$, $90°$ and $180°$. Examples, calculations. Gauss' law, statement: $\phi_E = q/\in_0$ or $\phi_E = \int \vec{E} \cdot d\vec{A} = q/\in_0$ where ϕ_E is for a closed surface; q is the net charge enclosed, $\in_o$ is the permittivity of free space. Essential properties of a Gaussian surface.

Applications: 1. Deduce Coulomb's law from the Gauss' law and certain symmetry considerations (No proof required); 2 (a). An excess charge placed on an isolated conductor resides on the outer surface; (b) $\vec{E}$ =0 inside a cavity in an isolated conductor; (c) $E = \sigma/\in_0$ for a point outside; 3. $\vec{E}$ due to an infinite line of charge, sheet of charge, spherical shell of charge (inside and outside); hollow spherical conductor. [Experimental test of coulomb's law not included].

(iii) Electric dipole; electric field at a point on the axis and perpendicular bisector of a dipole; electric dipole moment; torque on a dipole in a uniform electric field.

Electric dipole and dipole moment; with unit; derivation of the $\vec{E}$ at any point, (a) on the axis (b) on the perpendicular bisector of the *dipole, for r>> 2l. [$\vec{E}$ due to continuous distribution of charge, ring of charge, disc of charge etc not included]; dipole in uniform $\vec{E}$ electric field; net force zero, torque $\vec{\tau} = \vec{p} \times \vec{E}$.*

(iv) Electric lines of force.

A convenient way to visualize the electric field; properties of lines of force; examples of the lines of force due to an isolated point charge (+ve and - ve); dipole, two similar charges at a small distance; uniform field between two oppositely charged parallel plates.

(v) Electric potential and potential energy; potential due to a point charge and due to a dipole; potential energy of an electric dipole in an electric field. Van de Graff generator.

Brief review of conservative forces of which gravitational force and electric forces are examples; potential, pd and potential energy are defined only in a conservative field; electric potential at a point; definition $V_P=W/q_0$; hence $V_A - V_B = W_{BA}/q_0$ (taking q_0 from B to A) = $(q/4\pi\varepsilon_0)(^1/r_A - ^1/r_B)$; derive this equation; also $V_A = q/4\pi\varepsilon_0 . 1/r_A$; for q>0, $V_A>0$ and for q<0, $V_A < 0$. For a collection of charges V = sum of the potential due to each charge; potential due to a dipole on its axial line and equatorial line; also at any point for r>>d. Potential energy of a point charge (q) in an electric field $\vec{E}$, placed at a point P where potential is V, is given by U =qV and $\Delta U = q (V_A-V_B)$. The electrostatic potential energy of a system of two charges = work done $W_{21}=W_{12}$ in assembling the system; U_{12} or $U_{21} = (1/4\pi\varepsilon_0)\, q_1q_2/r_{12}$. For a system of 3 charges $U_{123} = U_{12} + U_{13} + U_{23}$ $= \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1q_2}{r_{12}} + \frac{q_1q_3}{r_{13}} + \frac{q_2q_3}{r_{23}}\right)$. For a dipole in a uniform electric field, the electric potential energy $U_E = -\vec{p}\cdot\vec{E}$, special case for $\phi = 0, 90^0$ and 180^0.

Van de Graff Generator. Potential inside a charged spherical shell is uniform. A small conducting sphere of radius r and carrying charge q is located inside a large shell of radius R that carries charge Q. The potential difference between the spheres, V(R) – V(r) = $(q/4\pi\varepsilon_o)$ (1/R – 1/r) is independent of Q. If the two are connected, charge always flows from the inner sphere to the outer sphere, raising its potential. Sketch of a very simple Van de Graff Generator, its working and use.

(vi) Capacitance of a conductor C = Q/V, the farad; capacitance of a parallel-plate capacitor; $C = K\in_0 A/d$ capacitors in series and parallel combinations; energy $U = {}^1/_2 CV^2$ $= \frac{1}{2}QV = \frac{1}{2}\frac{Q^2}{C}$.

Self-explanatory.

Combinations of capacitors in series and parallel; effective capacitance and charge distribution.

(vii) Dielectrics (elementary ideas only); permittivity and relative permittivity of a dielectric ($\in_r = \in/\in_o$). Effects on pd, charge and capacitance.

Dielectric constant $K_e = C'/C$; this is also called relative permittivity $K_e = \in_r = \in/\in_o$; elementary ideas of polarization of matter in a uniform electric field qualitative discussion; induced surface charges weaken the original field; results in reduction in $\vec{E}$ and hence, in pd, (V); for charge remaining the same $Q = CV = C' V' = K_e . CV'$; $V' = V/K_e$; and $E' = \frac{E}{K_e}$; if the C is kept connected with the source of emf, V is kept constant $V = Q/C = Q'/C'$; $Q'=C'V = K_e . CV = K_e . Q$ increases; For a parallel plate capacitor with a dielectric in between $C' = K_eC = K_e . \in_o . A/d = \in_r . \in_o . A/d$. Then, $C'' = \frac{\in_0 A}{\left(d/\in_r\right)}$; extending this to a partially filled capacitor $C' = \in_o A/(d-t + t/\in_r)$. Spherical and cylindrical capacitors (qualitative only).

2. Current Electricity

(i) Steady currents; sources of current, simple cells, secondary cells.

Sources of emf: Mention: Standard cell, solar cell, thermo-couple and battery, etc., acid/alkali cells - qualitative description.

(ii) Potential difference as the power supplied divided by the current; Ohm's law and its limitations; Combinations of resistors in series and parallel; Electric energy and power.

Definition of pd, $V = P/I$; $P = VI$; electrical energy consumed in time t is $E=Pt= VIt$; using ohm's law $E = VIt = \frac{V^2}{R}t = I^2Rt$. Electric power consumed $P = VI = V^2/R = I^2 R$; SI units; commercial units; electricity consumption and billing. Ohm's law, current density $\sigma = I/A$; experimental verification, graphs and slope, ohmic resistors; examples; deviations. Derivation of formulae for combination of resistors in series and parallel; special case of n identical resistors; $R_p = R/n$.

(iii) Mechanism of flow of current in metals, drift velocity of charges. Resistance and resistivity and their relation to drift velocity of electrons; description of resistivity and conductivity based on electron theory; effect of temperature on resistance, colour coding of resistance.

Electric current $I = Q/t$; atomic view of flow of electric current in metals; $I=v_d ena$. Electron theory of conductivity; acceleration of electrons, relaxation time τ; derive $\sigma = ne^2\tau/m$ and $\rho = m/ne^2 \tau$; effect of temperature on resistance. Resistance $R= V/I$ for ohmic substances; resistivity ρ, given by $R = \rho.l/A$; unit of ρ is $\Omega.m$; conductivity $\sigma=1/\rho$; Ohm's law as $\vec{J} = \sigma \vec{E}$; colour coding of resistance.

(iv) Electromotive force in a cell; internal resistance and back emf. Combination of cells in series and parallel.

The source of energy of a seat of emf (such as a cell) may be electrical, mechanical, thermal or radiant energy. The emf of a source is defined as the work done per unit charge to force them to go to the higher point of potential (from -ve terminal to +ve terminal inside the cell) so, $\varepsilon = dW/dq$; but $dq = Idt$; $dW = \varepsilon dq = \varepsilon Idt$. Equating total work done to the work done across the external resistor R plus the work done across the internal resistance r; $\varepsilon Idt=I^2R\,dt + I^2rdt$; $\varepsilon =I (R + r)$; $I=\varepsilon/(R + r)$; also $IR +Ir = \varepsilon$ or $V=\varepsilon- Ir$ where Ir is called the back emf as it acts against the emf ε; V is the terminal pd. Derivation of formula for combination of cells in series, parallel and mixed grouping.

(v) Kirchoff's laws and their simple applications to circuits with resistors and sources of emf; Wheatstone bridge, metre-bridge and potentiometer; use for comparison of emf and determination of internal resistance of sources of current; use of resistors (shunts and multipliers) in ammeters and voltmeters.

Statement and explanation with simple examples. The first is a conservation law for charge and the 2nd is law of conservation of energy. Note change in potential across a resistor $\Delta V=IR<0$ when we go 'down' with the current (compare with flow of water down a river), and $\Delta V=IR>0$ if we go up against the current across the resistor. When we go through a cell, the -ve terminal is at a lower level and the +ve terminal at a higher level, so going from -ve to +ve through the cell, we are going up and $\Delta V=+\varepsilon$ and going from +ve to -ve terminal through the cell we are going down, so $\Delta V = -\varepsilon$. Application to simple circuits. Wheatstone bridge; right in the beginning take $I_g=0$ as we consider a balanced bridge, derivation of $R_1/R_2 = R_3/R_4$ is simpler [Kirchoff's law not necessary]. Metre bridge is a modified form of Wheatstone bridge. Here $R_2 = l_1p$ and $R_4 =l_2 p$; $R_1/R_3 = l_1/l_2$. Potentiometer: fall in potential $\Delta V \alpha \Delta l$ - conditions; auxiliary emf ε_1 is balanced against the fall in potential V_1 across length l_1 . $\varepsilon_1 = V_1 =Kl_1$; $\varepsilon_1/\varepsilon_2 = l_1/l_2$; potentiometer as a voltmeter. Potential gradient; comparison of emfs; determination of internal resistance of a cell. Conversion of galvanometer to ammeter and voltmeter and their resistances.

(vi) Electrical Power

Changing global patterns of energy consumption.

Increased importance of electrical energy, different sources of electrical energy and different applications – starting from specific use like drawing water, lighting, powering locomotives, power of industrial equipments, etc. to eventually society being completely dependent on electrical power.

(Only qualitative understanding of this topic is required. No numerical required).

(vii) Thermoelectricity; Seebeck effect; measurement of thermo emf; its variation with temperature. Peltier effect.

Discovery of Seebeck effect. Seebeck series; Examples with different pairs of metals (for easy recall remember - hot cofe and ABC - from copper to iron at the hot junction and from antimony to bismuth at the cold junction for current directions in thermocouple); variation of thermo emf with temperature differences, graph; neutral temperature, temperature of inversion; slope: thermoelectric power $\varepsilon = \alpha\phi + 1/2\beta\phi^2$ *(no derivation),* $S = d\varepsilon/d\phi = \alpha+\beta\phi$*. The comparison of Peltier effect and Joule effect.*

3. Magnetism

(i) Magnetic field $\vec{B}$, definition from magnetic force on a moving charge; magnetic field lines. Superposition of magnetic fields; magnetic field and magnetic flux density; the earth's magnetic field; Magnetic field of a magnetic dipole; tangent law.

Magnetic field represented by the symbol $\bar{B}$ *is now defined by the equation* $\vec{F} = q_o\vec{V} \times \vec{B}$ *(which comes later under subunit 4.2;* $\vec{B}$ *is not to be defined in terms of force acting on a unit pole, etc; note the distinction of* $\vec{B}$ *from* $\vec{E}$ *is that* $\vec{B}$ *forms closed loops as there are no magnetic monopoles, whereas* $\vec{E}$ *lines start from +ve charge and end on -ve charge. Magnetic field lines due to a magnetic dipole (bar magnet). Magnetic field in end-on and broadside-on positions (No derivations). Magnetic flux* $\phi_B = \vec{B}.\vec{A} = BA$ *for B uniform and* $\vec{B} \parallel \vec{A}$*; i.e. area held perpendicular to* $\vec{B}$*. For* $\phi = BA(\vec{B} \parallel \vec{A})$*;* $B=\phi/A$ *is the flux density [SI unit of flux is weber (Wb)]; but note that this is not correct as a defining equation as* $\vec{B}$ *is vector and* ϕ *and* ϕ/A *are scalars, unit of B is tesla (T) equal to* 10^{-4} *gauss. For non-uniform* $\vec{B}$ *field,* $\phi = \int d\phi = \int \vec{B}.d\vec{A}$*. Earth's magnetic field* $\vec{B}_E$ *is uniform over a limited area like that of a lab; the component of this field in the horizontal directions* B_H *is the one effectively acting on a magnet suspended or pivoted horizontally. An artificial magnetic field is produced by a current carrying loop (see 4.2)* $\vec{B}_c$*, or a bar magnet* $\vec{B}_m$ *in the horizontal plane with its direction adjusted perpendicular to the magnetic meridian; this is superposed over the earth's fields* $\vec{B}_H$ *which is always present along the magnetic meridian. The two are then perpendicular to each other; a compass needle experiences a torque exerted by these fields and comes to an equilibrium position along the resultant field making an angle with ø with* B_H*. Then* B_c *- or* $B_m = B_H \tan ø$*. This is called tangent law. Deflection Magnetometer, description, setting and its working.*

(ii) Properties of dia, para and ferromagnetic substances; susceptibility and relative permeability

It is better to explain the main distinction, the cause of magnetization (M) is due to magnetic dipole moment (m) of atoms, ions or molecules being 0 for dia, >0 but very small for para and > 0 and large for ferromagnetic materials; few examples; placed in external $\vec{B}$*, very small (induced) magnetization in a direction opposite to* $\vec{B}$ *in dia, small magnetization parallel to* $\vec{B}$ *for para, and large magnetization parallel to* $\vec{B}$ *for ferromagnetic materials; this leads to lines of* $\vec{B}$ *becoming less dense, more dense and much more dense in dia, para and ferro, respectively; hence, a weak repulsion for dia,* *weak attraction for para and strong attraction for ferro - - - - - also a small bar suspended in the horizontal plane becomes perpendicular to the $\vec{B}$ field for dia and parallel to $\vec{B}$ for para and ferro. Defining equation H = (B/μ_0)-M; the magnetic properties, susceptibility χ_m = (M/H) < 0 for dia (as M is opposite H) and >0 for para, both very small, but very large for ferro; hence relative permeability μ_r =1+ χ_m < 1 for dia, > 1 for para and >>1(very large) for ferro; further, $\chi_m \propto 1/T$ (Curie's law) for para, independent of temperature (T) for dia and depends on T in a complicated manner for ferro; on heating ferro becomes para at Curie temperature.*

4. Electromagnetism

(i) Oersted's experiment; Biot-Savart law, the tesla; magnetic field near a long straight wire, at the centre of a circular loop, and at a point on the axis of a circular coil carrying current and a solenoid. Amperes circuital law and its application to obtain magnetic field due to a long straight wire; tangent galvanometer.

Only historical introduction through Oersted's experiment. [Ampere's swimming rule not included]. Biot-Savart law in vector form; application; derive the expression for B (i) near a very long wire carrying current; direction of $\vec{B}$ using right hand (clasp) rule- no other rule necessary; (ii) at the centre of a circular loop carrying current; (iii) at any point on its axis. Current carrying loop as a magnetic dipole. Ampere's Circuital law: statement and brief explanation. Apply it to obtain $\vec{B}$ near a long wire carrying current. Tangent galvanometer- theory, working, use, advantages and disadvantages.

(ii) Force on a moving charge in a magnetic field; force on a current carrying conductor kept in a magnetic field; force between two parallel current carrying wires; definition of the ampere based on the force between two current carrying wires. Cyclotron (simple idea).

Lorentz force equation $\vec{F}_B = q.\vec{v} \times \vec{B}$; special cases, modify this equation substituting $d\bar{l}/dt$ for v and I for q/dt to yield $\vec{F} = I\,d\vec{l} \times \vec{B}$ for the force acting on a current carrying conductor placed in a $\vec{B}$ field. Derive the expression for force between two long parallel wires carrying current, using Biot-Savart law and $\vec{F} = I\,d\vec{l} \times \vec{B}$; define ampere the base unit of SI and hence, coulomb from Q = It. Simple ideas about working of a cyclotron, its principle, and limitations.

(iii) A current loop as a magnetic dipole; magnetic dipole moment; torque on a current loop; moving coil galvanometer.

Derive the expression for torque on a current carrying loop placed in a uniform $\vec{B}$, using F = IlB and $\bar{\tau} = \bar{r} \times \bar{F}$ = NIAB sinϕ for N turns $\bar{\tau} = \bar{m} \, x \bar{B}$, where the dipole moment $\bar{m} = NI\bar{A}$ unit: A.m^2. A current carrying loop is a magnetic dipole; directions of current and $\vec{B}$ and $\vec{m}$ using right hand rule only; no other rule necessary. Mention orbital magnetic moment of electrons in Bohr model of H atom. Moving coil galvanometer; construction, principle, working, theory I= $k\phi$,advantages over tangent galvanometer.

(iv) Electromagnetic induction, magnetic flux and induced emf; Faraday's law and Lenz's law; transformers; eddy currents.

Magnetic flux, change in flux, rate of change of flux and induced emf; Faraday's law $\varepsilon = -d\phi/dt$, [only one law represented by this equation]. Lenz's law, conservation of energy; motional emf ε = Blv, and power P = (Blv)^2/R; eddy currents (qualitative); transformer (ideal coupling), principle, working and uses; step up and step down; energy losses.

(v) Mutual and self inductance: the henry. Growth and decay of current in LR circuit (dc) (graphical approach), time constant.

Mutual inductance, illustrations of a pair of coils, flux linked ϕ_2 = MI$_1$; induced emf $\varepsilon_2 = \frac{d\phi_2}{dt} = M\frac{dI_1}{dt}$. Definition of M as

$M = \dfrac{\varepsilon_2}{dI_1/dt}$ *or* $M = \phi_2 / I_1$ *. SI unit henry.*

Similar treatment for $L = \varepsilon / (dI/dt)$*; henry = volt. second/ampere [expressions for coefficient of self inductance L and mutual inductance M, of solenoid/coils and experiments, not included]. R-L circuit; induced emf opposes changes, back emf is set up, delays starting and closing, graphical representation of growth and decay of current in an R-L circuit [no derivation]; define and explain time constant from the graph;* $\tau = L/R$ *(result only). Unit of* τ *= unit of time = second. Hence, this name 'Time Constant'.*

(vi) Simple a.c. generators.

Principle, description, theory and use.

(v) Comparison of a.c. with d.c.

Variation in current and voltage with time for a.c. and d.c.

5. Alternating Current Circuits

(i) Change of voltage and current with time, the phase difference; peak and rms values of voltage and current; their relation in sinusoidal case.

Sinusoidal variation of V and I with time, for the output from an ac generator; time period, frequency and phase changes; rms value of V and I in sinusoidal cases only.

(ii) Variation of voltage and current in a.c. circuits consisting of only resistors, only inductors and only capacitors (phasor representation), phase lag and phase lead.

May apply Kirchoff's law and obtain simple differential equation (SHM type), $V = V_0 \sin \omega t$*, solution* $I = I_0 \sin \omega t$*,* $I_0 \sin(\omega t + \pi/2)$ *and* $I_0 \sin(\omega t - \pi/2)$ *for pure R, C and L circuits, respectively. Draw phase (or phasor) diagrams showing voltage and current and phase lag or lead; resistance R, inductive reactance* X_L*,* $X_L = \omega L$ *and capacitative reactance* X_C*,* $X_C = 1/\omega C$ *and their mutual relations. Graph of* X_L *and* X_C *vs f.*

(iii) The LCR series circuit: phasor diagram, expression for V or I; phase lag/lead; impedance of a series LCR circuit (arrived at by phasor diagram); Special cases for RL and RC circuits.

RLC circuit in single loop, note the pd across R, L and C; [the more able students may use Kirchoff's law and obtain the differential equation]. Use phasor diagram method to obtain expression for I or V and the net phase lag/lead; use the results of 5(ii), V lags I by $\pi/2$ *in a capacitor, V leads I by* $\pi/2$ *in an inductor, V and I are in phase in a resistor, I is the same in all three; hence draw phase diagram, combine* V_L *and Vc (in opposite phase; phasors add like vectors) to give* $V = V_R + V_L + V_C$ *(phasor addition) and the max. values are related by* $V^2_m = V^2_{RM} + (V_{Lm} - V_{Cm})^2$ *. Substituting pd=current x resistance or reactance, we get* $Z^2 = R^2 + (X_L - X_c)^2$ *and* $\tan\phi = (V_{L\,m} - V_{Cm})/V_{Rm} = (X_L - X_c)/R$ *giving* $I = I_m \sin(wt - \phi)$ *where* $I_m = V_m/Z$ *etc. Special cases for RL and RC circuits. Graph of Z vs f.*

(iv) Power P associated with LCR circuit $= \frac{1}{2} V_o I_o \cos\phi = V_{rms} I_{rms} \cos\phi$; power absorbed and power dissipated; choke coil (choke and starter); electrical resonance; bandwidth of signals; oscillations in an LC circuit ($\omega = 1/\sqrt{LC}$).

Average power consumed averaged over a full cycle $\overline{P} = (1/2)\, \varepsilon_m . I_m \cos\phi$*. Power factor* $\cos\phi = R/Z$*. Special case for pure R, L, C; choke coil:-* X_L *controls current but* $\cos\phi = 0$*, hence* $\overline{P} = 0$*; LC circuit; at resonance with* $X_L = X_c$ *,* $Z = Z_{min} = R$*, power delivered to circuit by the source, is maximum;* $\omega^2 = 1/LC$*;* $f = \dfrac{\omega}{2\pi}$*; definition and explanation of bandwidth.*

SECTION B

6. Wave Optics

(i) Complete electromagnetic spectrum from radio waves to gamma rays; transverse nature of electromagnetic waves, Huygen's principle; laws of reflection and refraction from Huygen's principle. Speed of light.

Qualitative descriptions only, but some wave length range values may be noted; common features of all regions of em spectrum including transverse nature ($\vec{E}$ and $\vec{B}$ perpendicular to $\vec{C}$); special features of the common classification (gamma rays, X rays, UV rays, visible spectrum, IR, microwaves, radio and TV waves) in their production (source), propagation, modulation and demodulation (qualitative only) – AM and FM, interaction with matter, detection and other properties; uses; approximate range of λ or f or at least proper order of increasing f or λ. Huygen's principle: wavefronts - different types/shapes, rays: Huygen's construction and Huygen's principle; proof of laws of reflection and refraction using this. [Refraction through a prism and lens on the basis of Huygen's theory: Not required]. Michelson's method to determine the speed of light.

(ii) Conditions for interference of light, interference of monochromatic light by double slit; measurement of wave length. Fresnel's biprism.

Phase of wave motion; superposition of identical waves at a point, path difference and phase difference; coherent and incoherent light waves; interference- constructive and destructive, conditions for sustained interference of light waves [mathematical deduction of interference from the equations of two progressive waves with a phase difference is not to be done]. Young's double slit experiment, set up, diagram, geometrical deduction of path difference $\Delta = d \sin \varnothing$, between waves (rays) from the two slits; using $\Delta = n\lambda$ for bright fringe and $(n+½)\lambda$ for dark fringe and $\sin \varnothing = \tan \varnothing = y_n/D$ as y and Ø are small, obtain $y_n = (D/d)n\lambda$ and fringe width $\beta = (D/d)\lambda$ etc. Experiment of Fresnel biprism (qualitative only). Measurement of β using a telescope; determination of λ, using $\lambda = \frac{\beta d}{D}$.

(iii) Single slit Fraunhofer diffraction (elementary explanation).

Diffraction at a single slit experimental setup, diagram, diffraction pattern, position of secondary maxima, conditions for secondary maxima, a $\sin\theta_n = (2n+1)\lambda/2$, for secondary minima a $\sin\theta_n = n\lambda$, where n = 1,2,3 …; distribution of intensity with angular distance; angular width of central bright fringe. Mention diffraction by a grating and its use in determining wave length of light (Details not required).

(iv) Plane polarised electromagnetic wave (elementary idea), polarisation of light by reflection. Brewster's law; polaroids.

Review description of an electromagnetic wave as transmission of energy by periodic changes in $\vec{E}$ and $\vec{B}$ along the path; transverse nature as $\vec{E}$ and $\vec{B}$ are perpendicular to $\vec{C}$ (velocity). These three vectors form a right handed system, so that $\vec{E}$ x $\vec{B}$ is along $\vec{C}$, they are mutually perpendicular to each other. For ordinary light, $\vec{E}$ and $\vec{B}$ are in all directions in a plane perpendicular to the $\vec{C}$ vector- unpolarised waves. If $\vec{E}$ and (hence $\vec{B}$ also) is confined to a single line only ($\perp\vec{C}$, we have linearly polarized light. The plane containing $\vec{E}$ (or $\vec{B}$) and $\vec{C}$ remains fixed. Hence, a linearly polarised light is also called plane polarised light. Plane of polarisation; polarisation by reflection; Brewster's law: $\tan i_p = n$; refracted ray is perpendicular to reflected ray for $i = i_p$; $i_p + r_p = 90°$; polaroids; use in production and detection/analysis of polarised light., other uses.

7. Ray Optics and Optical Instruments

(i) Refraction of light at a plane interface (Snell's law); total internal reflection and critical angle; total reflecting prisms and optical fibres.

Self-explanatory. Simple applications; numerical problems included.

(ii) Refraction through a prism, minimum deviation and derivation of relation between n, A and δ_{min}.

Include explanation of i-δ graph, $i_1 = i_2 = i$ (say) for δ_m; from symmetry $r_1 = r_2$; refracted *ray inside the prism is parallel to the base of the prism; application to triangular prisms with angle of the prism 30^0, 45^0, 60^0 and 90^0 respectively; ray diagrams.*

(iii) Refraction at a single spherical surface (relation between n_1, n_2, u, v and R); refraction through thin lens (lens maker's formula and formula relating u, v, f, n, R_1 and R_2); combined focal length of two thin lenses in contact. Combination of lenses and mirrors [Silvering of lens excluded].

Self-explanatory.

Limit detailed discussion to one case only-convex towards rarer medium, for spherical surface and real image. For lens, derivation only for biconvex lens with $R_1= R_2$; extend the results to biconcave lens, plano convex lens and lens immersed in a liquid; do also power of a lens P=1/f with SI unit dioptre. For lenses in contact $1/F= 1/f_1+1/f_2$ and $P=P_1+P_2$. Formation of image and determination of focal length with combination of thin lenses.

(iv) Dispersion; dispersive power; production of pure spectrum; spectrometer and its setting (experimental uses and procedures included); absorption and emission spectra; spherical and chromatic aberration; derivation of condition for achromatic combination of two thin lenses in contact and not of prism.

Angular dispersion; dispersive power, conditions for pure spectrum; spectrometer with experiments for A and δ. Hence, δ_m and n; rainbow - ray diagram (no derivation). Simple explanation. Spectra: emission spectra; line; band and continuous spectra-their source and qualitative explanation; absorption spectra - condition; solar spectrum and Fraunhofer lines, spherical aberration in a convex lens (qualitative only), how to reduce linear or axial chromatic aberration, derivations, condition for achromatic combination of two lenses in contact.

(v) Simple microscope; Compound microscope and their magnifying power.

For microscope - magnifying power for image at least distance of distinct vision; ray diagrams, numerical problems included.

(vi) Simple astronomical telescope (refracting and reflecting), magnifying power and resolving power of a simple astronomical telescope.

Ray diagrams of reflecting as well as refracting telescope with image at infinity only; simple explanation; magnifying power; resolving power, advantages, disadvantages and uses.

(vii) Human Eye, Defects of vision and their correction.

Working, accommodation, near point, far point, shortsightedness, longsightedness. Their correction with the help of lenses. Numericals included.

SECTION C

8. Electrons and Photons

(i) Cathode rays: measurement of e/m for electrons. Millikan's oil drop experiment.

Production of cathode rays – only brief and qualitative [historical details not included]. Thomson's experiment to measure e/m of electrons: $e/m=(½V)\,(E/B)^2$.

Thermionic emission, deflection of charged particle by $\vec{E}$ and $\vec{B}$, and fluorescence produced by electron. Millikan's oil drop experiment - quantization of charge.

(ii) Photo electric effect, quantization of radiation; Einstein's equation; threshold frequency; work function; energy and momentum of photon. Determination of Planck's Constant.

Experimental facts; do topics as given; note Einstein used Planck's ideas and extended it to apply for radiation (light); photoelectric effect can be explained only assuming quantum (particle) nature of radiation. Theory and experiment for determination of Planck's constant (from the graph of stopping potential V versus frequency f of the incident light). Momentum of photon $p=E/c=hf/c=h/\lambda$.

(iii) Wave particle duality, De Broglie equation, phenomenon of electron diffraction (informative only).

Dual nature of radiation already discussed; wave nature in interference, diffraction and polarization; particle nature in photoelectric effect and Compton effect. Dual nature of matter: particle nature common in that it possess momentum p=mv and kinetic energy $K=\frac{1}{2}mv^2$. The wave nature of matter was proposed by Louis de Broglie $\lambda=h/p=h/mv$. Davisson and Germer experiment; qualitative description and discussion of the experiment, polar graph. No numerical problem.

9. Atoms

(i) Charge and size of nuclei (α-particle scattering); atomic structure; Bohr's postulates, Bohr's quantization condition; radii of Bohr orbits for hydrogen atom; energy of the hydrogen atom in the nth state; line spectra of hydrogen and calculation of E and f for different lines.

Rutherford's nuclear model of atom (mathematical theory of scattering excluded), based on Geiger - Marsden experiment on α-scattering; nuclear radius r in terms of closest approach of α particle to the nucleus, obtained by equating $\Delta K=\frac{1}{2}mv^2$ of the α particle to the change in electrostatic potential energy ΔU of the system $[(1/4\pi\varepsilon_0(2e)(Ze)/r_0]$; $r_0 \sim 10^{-15}$m =1 fm or 1 fermi; atomic structure; only general qualitative ideas, including, atomic number Z, Neutron number N and mass number A. A brief account of historical background leading to Bohr's theory of hydrogen spectra; empirical formula for Lyman, Balmer and Paschen series. Bohr's model of H atom, postulates (Z=1); expressions for orbital velocity, kinetic energy, potential energy, radius of orbit and total energy of electron. Energy level diagram for n=1,2,3… calculation of ΔE, frequency and wavelength of different lines of emission spectra; agreement with experimentally observed values. [Use nm and not Å for unit of λ].

(ii) Production of X-rays; maximum frequency for a given tube potential. Characteristic and continuous X -rays. Moseley's law.

A simple modern X-ray tube (Coolidge tube) – main parts: hot cathode, heavy element target kept cool and anode, all enclosed in a vacuum tube; elementary theory of X-ray production; effect of increasing filament current-temperature increases rate of emission of electrons (from the cathode), rate of production of X rays and hence, intensity of X rays increases (not its frequency); increase in anode potential increases energy of each electron, each X-ray photon and hence, X-ray frequency (E=hf); maximum frequency $hf_{max}=eV$; continuous spectrum of X rays has minimum wavelength $\lambda_{min}= c/f_{max}$. Moseley's law. Characteristic and continuous X-rays; origin.

10. Nuclei

(i) Atomic masses; unified atomic mass unit u and its value in MeV; the neutron; composition and size of nucleus; mass defect and binding energy.

Atomic masses; unified atomic mass unit, symbol u, 1u=1/12 of the mass of ^{12}C atom = 1.66×10^{-27}kg). Composition of nucleus; mass defect and binding energy $BE=(\Delta m)c^2$. Graph of BE/nucleon versus mass number A, special features - low for light as well as heavy elements. Middle order more stable [see fission and fusion in 11.(ii), 11.(iii)].

(ii) Radioactivity: nature and radioactive decay law, half-life, mean life and decay constant. Nuclear reactions.

Discovery; spontaneous disintegration of an atomic nucleus with the emission of α or β particles and γ radiation, unaffected by ordinary chemical changes. Radioactive decay law; derivation of $N = N_o e^{-\lambda t}$; half life period T; graph of N versus t, with T marked on the X axis. Relation between T and λ; mean life τ and λ. Value of T of some common radioactive elements. Examples of few nuclear reactions with conservation of nucleon number and charge. (neutrino to be included

Dangers of leakages of radiation, e.g. Chernobyl, importance of judicious scrap disposal (e.g. Mayapuri Scrap Market in Delhi), Outcome of atomic bombs in Hiroshima and Nagasaki.

[Mathematical theory of α and β decay not included]. Changes taking place within the nucleus included.

11. Nuclear Energy

(i) Energy - mass equivalence.

Einstein's equation $E=mc^2$. Some calculations. (already done under 10.(i)); mass defect/binding energy, mutual annihilation and pair production as examples.

(ii) Nuclear fission; chain reaction; principle of operation of a nuclear reactor.

(iii) Nuclear fusion; thermonuclear fusion as the source of the sun's energy.

Theoretical (qualitative) prediction of exothermic (with release of energy) nuclear reaction, in fusing together two light nuclei to form a heavier nucleus and in splitting heavy nucleus to form middle order (lower mass number) nucleus, is evident from the shape of BE per nucleon versus mass number graph. Also calculate the disintegration energy Q for a heavy nucleus (A=240) with BE/A ~ 7.6 MeV per nucleon split into two equal halves with A=120 each and BE/A ~ 8.5 MeV/nucleon; Q ~ 200 MeV. Discovery of fission. Any one equation of fission reaction. Chain reaction- controlled and uncontrolled; nuclear reactor and nuclear bomb. Main parts of a nuclear reactor including a simple diagram and their functions - fuel elements, moderator, control rods, coolant, casing; criticality; utilization of energy output - all qualitative only. Fusion, simple example of $4\,{}^1H \rightarrow {}^4He$ and its nuclear reaction equation; requires very high temperature ~ 10^6 degrees; difficult to achieve; hydrogen bomb; thermonuclear energy production in the sun and stars. [Details of chain reaction not required].

12. Semiconductor Devices

(i) Energy bands in solids; energy band diagrams for distinction between conductors, insulators and semi-conductors - intrinsic and extrinsic; electrons and holes in semiconductors.

Elementary ideas about electrical conduction in metals [crystal structure not included]. Energy levels (as for hydrogen atom), 1s, 2s, 2p, 3s , etc. of an isolated atom such as that of copper; these split, eventually forming 'bands' of energy levels, as we consider solid copper made up of a large number of isolated atoms, brought together to form a lattice; definition of energy bands - groups of closely spaced energy levels separated by band gaps called forbidden bands. An idealized representation of the energy bands for a conductor, insulator and semiconductor; characteristics, differences; distinction between conductors, insulators and semiconductors on the basis of energy bands, with examples; qualitative discussion only; energy gaps (eV) in typical substances (carbon, Ge, Si); some electrical properties of semiconductors. Majority and minority charge carriers - electrons and holes; intrinsic and extrinsic, doping, p-type, n-type; donor and acceptor impurities. [No numerical problems from this topic].

(ii) Junction diode; depletion region; forward and reverse biasing current - voltage characteristics; pn diode as a half wave and a full wave rectifier; solar cell, LED and photodiode. Zener diode and voltage regulation.

Junction diode; symbol, simple qualitative description only [details of different types of formation not included]. The topics are self explanatory. [Bridge rectifier of 4 diodes not included]. Simple circuit diagram and graphs, function of each component - in the electric circuits, qualitative only. Elementary ideas on solar cell, photodiode and light emitting diode (LED) as semi conducting diodes. Importance of LED's as they save energy without causing atmospheric pollution and global warming. Self explanatory.

(iii) The junction transistor; npn and pnp transistors; current gain in a transistor; transistor (common emitter) amplifier (only circuit diagram and qualitative treatment) and oscillator.

Simple qualitative description of construction - emitter, base and collector; npn and pnp type; symbol showing directions of current in *emitter-base region (one arrow only)- base is narrow; current gain in transistor; common emitter configuration only, characteristics; I_B vs V_{BE} and I_C vs V_{CE} with circuit diagram; no numerical problem; common emitter transistor amplifier - correct diagram; qualitative explanation including amplification, wave form and phase reversal. [relation between α, β not included, no numerical problems]. Circuit diagram and qualitative explanation of a simple oscillator.*

(iv) Elementary idea of discreet and integrated circuits, analogue and digital circuits. Logic gates (symbols; working with truth tables; applications and uses) - NOT, OR, AND, NOR, NAND.

Self explanatory. Advantages of IC.

Introduction to elementary digital electronics. Logic gates as given; symbols, input and output, Boolean equations (Y=A+B etc), truth table, qualitative explanation. [No numerical problems. Realisation not included].

PAPER II

PRACTICAL WORK- 20 Marks

The experiments for laboratory work and practical examinations are mostly from two groups; (i) experiments based on ray optics and (ii) experiments based on current electricity. The main skill required in group (i) is to remove parallax between a needle and the real image of another needle. In group (ii), understanding circuit diagram and making connections strictly following the given diagram is very important. Take care of polarity of cells and meters, their range, zero error, least count, etc. A graph is a convenient and effective way of representing results of measurement. Therefore, it is an important part of the experiment. Usually, there are two graphs in all question papers. Students should learn to draw graphs correctly noting all important steps such as title, selection of origin, labelling of axes (not x and y), proper scale and the units given along each axis. Use maximum area of graph paper, plot points with great care, mark the points plotted with ⊙ or ⊗ and draw the best fit straight line (not necessarily passing through all the plotted points), keeping all experimental points symmetrically placed (on the line and on the left and right side of the line) with respect to the best fit thin straight line. Read intercepts carefully. Y intercept i.e. y_0 is that value of y when x = 0. Slope 'm' of the best fit line should be found out using two distant points, one of which should be unplotted point, using $m = \frac{y_2 - y_1}{x_2 - x_1}$.

NOTE:

Short answer questions may be set from each experiment to test understanding of theory and logic of steps involved.

The list of experiments given below is only a general recommendation. Teachers may add, alter or modify this list, keeping in mind the general pattern of questions asked in the annual examinations.

1. Draw the following set of graphs using data from lens experiments -
   i) ν against u. It will be a curve.
   ii) Magnification $\left(m = \frac{v}{u}\right)$ against ν and to find focal length by intercept.
   iii) y = 100/v against x = 100/u and to find f by intercepts.
2. To find f of a convex lens by using u-v method.
3. To find f of a convex lens by displacement method.
4. Coaxial combination of two convex lenses not in contact.
5. Using a convex lens, optical bench and two pins, obtain the positions of the images for various positions of the object; f<u<2f, u~2f, and u>2f. Plot a graph of y=100/v versus x=100/u. Obtain the focal length of the lens from the intercepts, read from the graph.
6. Determine the focal length of a concave lens, using an auxiliary convex lens, not in contact and plotting appropriate graph.
7. Refractive index of material of lens by Boys' method.
8. Refractive index of a liquid by using convex lens and plane mirror.

9. Using a spectrometer, measure the angle of the given prism and the angle of minimum deviation. Calculate the refractive index of the material. [A dark room is not necessary].
10. Set up a deflection magnetometer in Tan-A position, and use it to compare the dipole moments of the given bar magnets, using (a) deflection method, neglecting the length of the magnets and (b) null method.
11. Set up a vibration magnetometer and use it to compare the magnetic moments of the given bar magnets of equal size, but different strengths.
12. Determine the galvanometer constant of a tangent galvanometer measuring the current (using an ammeter) and galvanometer deflection, varying the current using a rheostat. Also, determine the magnetic field at the centre of the galvanometer coil for different values of current and for different number of turns of the coil.
13. Using a metre bridge, determine the resistance of about 100 cm of constantan wire, measure its length and radius and hence, calculate the specific resistance of the material.
14. Verify Ohm's law for the given unknown resistance (a 60 cm constantan wire), plotting a graph of potential difference versus current. From the slope of the graph and the length of the wire, calculate the resistance per cm of the wire.
15. From a potentiometer set up, measure the fall in potential for increasing lengths of a constantan wire, through which a steady current is flowing; plot a graph of pd V versus length l. Calculate the potential gradient of the wire. Q (i) Why is the current kept constant in this experiment? Q (ii) How can you increase the sensitivity of the potentiometer? Q (iii) How can you use the above results and measure the emf of a cell?
16. Compare the emf of two cells using a potentiometer.
17. To study the variation in potential drop with length of slide wire for constant current, hence to determine specific resistance.
18. To determine the internal resistance of a cell by potentiometer device.
19. Given the figure of merit and resistance of a galvanometer, convert it to (a) an ammeter of range, say 2A and (b) a voltmeter of range 4V. Also calculate the resistance of the new ammeter and voltmeter.
20. To draw I-V characteristics of a semi-conductor diode in forward and reverse bias.
21. To draw characteristics of a Zener diode and to determine its reverse breakdown voltage.
22. To study the characteristics of pnp/npn transistor in common emitter configuration.
23. To determine refractive index of a glass slab using a traveling microscope.

PROJECT WORK AND PRACTICAL FILE – 10 Marks

Project Work – 7 Marks

The Project work is to be assessed by a Visiting Examiner appointed locally and approved by the Council.

All candidates will do project work involving some physics related topics, under the guidance and regular supervision of the Physics teacher.

Candidates are to prepare a technical report formally written including an abstract, some theoretical discussion, experimental setup, observations with tables of data collected, analysis and discussion of results, deductions, conclusion, etc. (after the draft has been approved by the teacher). The report should be kept simple, but neat and elegant. No extra credit shall be given for typewritten material/decorative cover, etc. Teachers may assign or students may choose any one project of their choice.

Practical File – 3 Marks

The Visiting Examiner is required to assess students on the basis of the Physics practical file maintained by them during the academic year.