

Dispersion; Angular dispersion; dispersive power, rainbow - ray diagram (no derivation). Simple explanation.

- (d) *Refraction at a single spherical surface; detailed discussion of one case only - convex towards rarer medium, for spherical surface and real image. Derive the relation between n_1 , n_2 , u , v and R . Refraction through thin lenses: derive lens maker's formula and lens formula; derivation of combined focal length of two thin lenses in contact. Combination of lenses and mirrors (silvering of lens excluded) and magnification for lens, derivation for biconvex lens only; extend the results to biconcave lens, plano convex lens and lens immersed in a liquid; power of a lens $P=1/f$ with SI unit dioptre. For lenses in contact $1/F=1/f_1+1/f_2$ and $P=P_1+P_2$. Lens formula, formation of image with combination of thin lenses and mirrors.*

[Any one sign convention may be used in solving numericals].

- (e) *Ray diagram and derivation of magnifying power of a simple microscope with image at D (least distance of distinct vision) and infinity; Ray diagram and derivation of magnifying power of a compound microscope with image at D . Only expression for magnifying power of compound microscope for final image at infinity.*

Ray diagrams of refracting telescope with image at infinity as well as at D ; simple explanation; derivation of magnifying power; Ray diagram of reflecting telescope with image at infinity. Advantages, disadvantages and uses.

(ii) Wave Optics

Wave front and Huygen's principle. Proof of laws of reflection and refraction using Huygen's principle. Interference, Young's double slit experiment and expression for fringe width(β), coherent sources and sustained interference of light, Fraunhofer

diffraction due to a single slit, width of central maximum.

- (a) *Huygen's principle: wavefronts - different types/shapes of wavefronts; proof of laws of reflection and refraction using Huygen's theory. [Refraction through a prism and lens on the basis of Huygen's theory not required].*

- (b) *Interference of light, interference of monochromatic light by double slit. Phase of wave motion; superposition of identical waves at a point, path difference and phase difference; coherent and incoherent sources; 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 required]. Young's double slit experiment: set up, diagram, geometrical deduction of path difference $\Delta x = d \sin \theta$, between waves from the two slits; using $\Delta x = n\lambda$ for bright fringe and $\Delta x = (n + \frac{1}{2})\lambda$ for dark fringe and $\sin \theta = \tan \theta = y_n / D$ as y and θ are small, obtain $y_n = (D/d)n\lambda$ and fringe width $\beta = (D/d)\lambda$. Graph of distribution of intensity with angular distance.*

- (c) *Single slit Fraunhofer diffraction (elementary explanation, qualitative treatment only). Diffraction at a single slit: experimental setup, diagram, diffraction pattern, obtain expression for position of minima, $a \sin \theta_n = n\lambda$, where $n = 1, 2, 3 \dots$ and conditions for secondary maxima, $a \sin \theta_n = (n + \frac{1}{2})\lambda$; distribution of intensity with angular distance; angular width of central bright fringe.*

7. Dual Nature of Radiation and Matter

Wave particle duality; photoelectric effect, Hertz and Lenard's observations; Einstein's photoelectric equation - particle nature of light. Matter waves - wave nature of particles, de-Broglie relation.

- (a) Photo electric effect, quantization of radiation; Einstein's equation $E_{\max} = h\nu - W_0$; threshold frequency; work function; experimental facts of Hertz and Lenard and their conclusions; 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. Determination of Planck's constant (from the graph of stopping potential V_s versus frequency f of the incident light). Momentum of photon $p = E/c = h\nu/c = h/\lambda$.
- (b) De Broglie hypothesis, phenomenon of electron diffraction (qualitative only). Wave nature of radiation is exhibited in interference, diffraction and polarisation; particle nature is exhibited in photoelectric effect. Dual nature of matter: particle nature common in that it possesses momentum p and kinetic energy KE . The wave nature of matter was proposed by Louis de Broglie, $\lambda = h/p = h/mv$.

8. Atoms and Nuclei

(i) Atoms

Alpha-particle scattering experiment; Rutherford's atomic model; Bohr's atomic model, energy levels, hydrogen spectrum.

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 $[U = \frac{2e \times Ze}{4\pi\epsilon_0 r_0}]$ $r_0 \sim 10^{-15} m = 1$ 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 spectrum; formulae for wavelength in Lyman, Balmer, Paschen, Brackett and Pfund series. Rydberg constant. 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, calculation of ΔE , frequency and wavelength of different lines of emission spectra; agreement with experimentally observed values. [Use nm and not \AA for unit of λ].

(ii) Nuclei

Composition and size of nucleus. Mass-energy relation, mass defect; binding energy per nucleon and its variation with mass number; Nuclear reactions, nuclear fission and nuclear fusion.

(a) Atomic masses and nuclear density; Isotopes, Isobars and Isotones – definitions with examples of each. Unified atomic mass unit, symbol u , $1u = 1/12$ of the mass of ^{12}C atom = $1.66 \times 10^{-27} \text{kg}$). Composition of nucleus; mass defect and binding energy, $BE = (\Delta m) c^2$. Graph of $BE/\text{nucleon}$ versus mass number A , special features - less $BE/\text{nucleon}$ for light as well as heavy elements. Middle order more stable [see fission and fusion] Einstein's equation $E = mc^2$. Calculations related to this equation; mass defect/binding energy, mutual annihilation and pair production as examples.

(b) Nuclear 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) nuclei, 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 $BE/A \sim 7.6$ MeV per nucleon split into two equal halves with $A=120$ each and $BE/A \sim 8.5$ MeV/nucleon; $Q \sim 200$ MeV. Nuclear fission: Any one equation of fission reaction. Chain reaction-controlled and uncontrolled; nuclear reactor and nuclear bomb. Main parts of a nuclear reactor including their functions - fuel elements, moderator, control rods, coolant, casing; criticality;

utilization of energy output - all qualitative only. Fusion, simple example of $4\ ^1\text{H} \rightarrow\ ^4\text{He}$ and its nuclear reaction equation; requires very high temperature $\sim 10^6$ degrees; difficult to achieve; hydrogen bomb; thermonuclear energy production in the sun and stars. [Details of chain reaction not required].

9. Electronic Devices

(i) Semiconductor Electronics: Materials, Devices and Simple Circuits. Energy bands in conductors, semiconductors and insulators (qualitative ideas only). Intrinsic and extrinsic semiconductors.

(ii) Semiconductor diode: I-V characteristics in forward and reverse bias, diode as a rectifier; Special types of junction diodes: LED, photodiode and solar cell.

(a) *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.

(b) *Junction diode and its symbol; depletion region and potential barrier; forward and reverse biasing, V-I characteristics and numericals; half wave and a full wave rectifier. Simple circuit diagrams and graphs, function of each component in the electric circuits, qualitative only. [Bridge rectifier of 4 diodes not included]; 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.*

PAPER II

PRACTICAL WORK- 15 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. Polarity of cells and meters, their range, zero error, least count, etc. should be taken care of.

A graph is a convenient and effective way of representing results of measurement. It is an important part of the experiment.

There will be one graph in the Practical question paper.

Candidates are advised to read the question paper carefully and do the work according to the instructions given in the question paper. Generally they are not expected to write the procedure of the experiment, formulae, precautions, or draw the figures, circuit diagrams, etc.

Observations should be recorded in a tabular form.

Record of observations

- All observations recorded should be consistent with the least count of the instrument used (e.g. focal length of the lens is 10.0 cm or 15.1cm but **10 cm is a wrong record.**)
- All observations should be recorded with correct units.

Graph work

Students should learn to draw graphs correctly noting all important steps such as:

- (i) Title
- (ii) Selection of origin (should be marked by two coordinates, example 0,0 or 5,0, or 0,10 or 30,5; **Kink is not accepted**).
- (i) The axes should be labelled according to the question
- (ii) Uniform and convenient scale should be taken and the units given along each axis (one small division = 0.33, 0.67, 0.66, etc. should not to be taken)
- (iii) Maximum area of graph paper (**at least 60% of the graph paper along both the axes**) should be used.
- (iv) Points should be plotted with great care, marking the points plotted with (should be a circle with a dot) \square or \otimes . A blob (●) is a misplot.
- (v) The best fit straight line should be drawn. The best fit line does not necessarily have to pass through all the plotted points and the origin. While drawing the best fit line, **all experimental points must be kept on the line or symmetrically placed on the left and right side of the line**. The line should be continuous, thin, uniform and extended beyond the extreme plots.
- (vi) The intercepts must be read carefully. Y intercept i.e. y_0 is that value of y when $x = 0$. Similarly, X intercept i.e. x_0 is that value of x when $y=0$. **When x_0 and y_0 are to be read, origin should be at (0, 0).**

Deductions

- (i) The slope 'S' of the best fit line must be found taking two distant points (**using more than 50% of the line drawn**), which are not the plotted points, using $S = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\Delta y}{\Delta x}$. Slope S must be calculated upto proper decimal place or significant figures as specified in the question paper.
- (ii) All calculations should be rounded off upto proper decimal place or significant figures, as specified in the question papers.

NOTE:

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

Given below is a list of required experiments. Teachers may add to this list, keeping in mind the general pattern of questions asked in the annual examinations.

Students are required to have completed all experiments from the given list (excluding demonstration experiments):

1. To find focal length of a convex lens by using u-v method (no parallax method)

Using a convex lens, optical bench/metre scales and two pins, obtain the positions of the images for various positions of the object; $f < u < 2f$, $u \sim 2f$, and $u > 2f$.

Draw the following set of graphs using data from the experiments -

- (i) v against u. It will be a curve.
- (ii) Magnification $\left(m = \frac{v}{u}\right)$ against v which is a straight line and to find focal length by intercept.
- (iii) $y = (100/v)$ against $x = (100/u)$ which is a straight line and find f by intercepts.

2. To find f of a convex lens by displacement method.
3. To determine the focal length of a given convex lens with the help of an auxiliary convex lens.
4. To determine the focal length of a concave lens, using an auxiliary convex lens, not in contact and plotting appropriate graph.
5. To determine focal length of concave mirror by using two pins (by u-v method).
6. To determine the refractive index of a liquid by using a convex lens and a plane mirror.
7. To determine the focal length of a convex mirror using convex lens.
8. 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.

9. Verify Ohm's law for the given unknown resistance (a 60 cm constantan wire), plotting a graph of potential difference versus current. Also calculate the resistance per cm of the wire from the slope of the graph and the length of the wire.
10. To determine the internal resistance of a cell by a potentiometer.
11. From a potentiometer set up, measure the fall in potential (i.e. pd) 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 and specific resistance of its material. 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?
12. To verify the laws of combination of resistances (series and parallel) using metre bridge.

Demonstration Experiments (The following experiments are to be demonstrated by the teacher):

1. To convert a given galvanometer into (a) an ammeter of range, say 2A and (b) a voltmeter of range 4V.
2. To study I-V characteristics of a semi-conductor diode in forward and reverse bias.
3. To determine refractive index of a glass slab using a traveling microscope.
4. Identification of diode, LED, transistor, IC, resistor, capacitor from mixed collection of such items.
5. Use of multimeter to (i) identify base of transistor, (ii) distinguish between npn and pnp type transistors, (iii) see the unidirectional flow of current in case of diode and an LED, (iv) check whether a given electronic component (e.g. diode, transistors, IC) is in working order.
6. Charging and discharging of a capacitor.

PROJECT WORK AND PRACTICAL FILE –

15 marks

Project Work – 10 marks

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

All candidates will be required to do **one** project involving some physics related topic/s under the guidance and regular supervision of the Physics teacher.

Candidates should undertake any **one** of the following types of projects:

- Theoretical project
- Working Model
- Investigatory project (by performing an experiment under supervision of a teacher)

Candidates are to prepare a technical report including title, abstract, some theoretical discussion, experimental setup, observations with tables of data collected, graph/chart (if any), analysis and discussion of results, deductions, conclusion, etc. The teacher should approve the draft, before it is finalised. The report should be kept simple, but neat and elegant. Teachers may assign or students may choose **any one** project of their choice.

Suggested Evaluation Criteria for Theory Based Projects:

▪ Title of the Project
▪ Introduction
▪ Contents
▪ Analysis/ material aid (graph, data, structure, pie charts, histograms, diagrams, etc.)
▪ Originality of work (the work should be the candidates' original work,)
▪ Conclusion/comments

Suggested Evaluation Criteria for Model Based Projects:

▪ Title of the Project
▪ Model construction
▪ Concise Project report

Suggested Evaluation Criteria for Investigative Projects:

▪ Title of the Project
▪ Theory/principle involved
▪ Experimental setup
▪ Observations calculations/deduction and graph work
▪ Result/ Conclusions

Practical File – 5 marks

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