

PHYSICS
PAPER – 1
(THEORY)
(Three hours)

*(Candidates are allowed additional 15 minutes for **only** reading the paper.
They must NOT start writing during this time.)*

*Answer **all** questions in **Part I** and **six** questions from **Part II**, choosing **two** questions
from **each** of the Sections **A**, **B** and **C**.*

*All working, including rough work, should be done on the same sheet as, and adjacent to,
the rest of the answer.*

The intended marks for questions or parts of questions are given in brackets [].

(Material to be supplied: Log tables including Trigonometric functions)

A list of useful physical constants is given at the end of this paper.

PART I (20 Marks)

*Answer **all** questions.*

Question 1

A. Choose the correct alternative (a), (b), (c) or (d) for each of the questions given below: **[5]**

- (i) Two point charges $17.7 \mu\text{C}$ and $-17.7 \mu\text{C}$, separated by a very small distance, are kept inside a large hollow metallic sphere. Electric flux emanating through the sphere is:
- (a) $2 \times 10^6 \text{ Vm}$
 - (b) $-2 \times 10^6 \text{ Vm}$
 - (c) Zero
 - (d) $4 \times 10^6 \text{ Vm}$
- (ii) Ohm's Law, in vector form is:
- (a) $\vec{J} = \rho \vec{E}$
 - (b) $\vec{J} = \sigma \vec{E}$
 - (c) $V = IR$
 - (d) $\vec{E} = \sigma \vec{J}$

- (iii) If the current (I) flowing through a circular coil, its radius (R) and number of turns (N) in it are each doubled, magnetic flux density at its centre becomes:
- Two times
 - Four times
 - Eight times
 - Sixteen times
- (iv) If two thin lenses having focal lengths f_1 and f_2 and dispersive powers (of their materials) ω_1 and ω_2 respectively, are kept in contact, condition for their achromatism is:
- $\omega_1 f_1 + \omega_2 f_2 = 0$
 - $\omega_1 (f_1)^2 + \omega_2 (f_2)^2 = 0$
 - $\frac{\omega_1}{f_1} = -\frac{\omega_2}{f_2}$
 - $\frac{\omega_1}{f_1^2} = -\frac{\omega_2}{f_2^2}$
- (v) Ratio of the radius of third Bohr orbit to the radius of second Bohr orbit in hydrogen atom is:
- 2:3
 - 4:9
 - 9:4
 - 3:2

B. Answer **all** questions given below briefly and to the point:

[15]

- A dielectric slab of relative permittivity (i.e. dielectric constant) 6 is introduced between the two plates of an $8\mu\text{F}$ air capacitor, in order to completely occupy the space between the two plates. Find the new capacitance of the capacitor.
- What is the ratio $P_1 : P_2$ of electric power developed in R_1 and R_2 shown in **Figure 1** below?

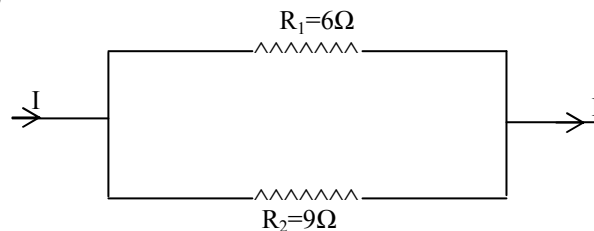


Figure 1

- (iii) Current 'I' flowing through a metallic wire of area of cross-section 'a' is given by the equation $I = naev_d$. What is the meaning of the symbols 'n' and 'v_d'?
- (iv) State *two* conditions which must be satisfied in order to apply Tangent law in magnetism.
- (v) A metallic wire carrying a current is kept in a uniform magnetic field, at different angles. At what angle, is the force acting on it maximum?
- (vi) What type of wave front is associated with a line source of light?
- (vii) Calculate the polarizing angle for glass whose refractive index is 1.6.
- (viii) What is the optical power in dioptre of a concave lens of focal length 50 cm?
- (ix) What is meant by 'resolving power' of a telescope?
- (x) How can the defect of short sightedness be corrected?
- (xi) Out of the following, which one cannot be the charge of a body?
 $+8.0 \times 10^{-19}C$, $-3.2 \times 10^{-19}C$, $2.4 \times 10^{-19}C$, or $6.4 \times 10^{-19}C$
- (xii) Name the *series* of lines in the hydrogen spectrum which lies in the *infrared* region.
- (xiii) Explain the statement: "Half life of Polonium is 3.8 days."
- (xiv) How much matter has to be destroyed to create $9 \times 10^{13}J$ of energy?
- (xv) In Semi-Conductor Physics, what is LED?

PART II (50 Marks)

Answer six questions in this part, choosing two questions from each of the Sections A, B and C.

SECTION A

Answer any two questions.

Question 2

- (a) **Figure 2** below shows an electric dipole AB of length l kept in a uniform electric field \vec{E} : [3]

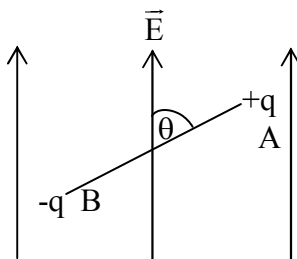


Figure 2

- (i) Show the electrostatic force acting on *each* of the charges forming the dipole.

- (ii) Hence, obtain an expression for the torque acting on the dipole.
- (b) Two plates of a charged parallel plate capacitor are pulled apart with the help of insulating handles, till their separation is doubled. [3]
- Compare the new electrostatic potential energy of the capacitor with the old.
- (c) In **Figure 3** below, find the reading of the voltmeter(V), having a resistance of 2000Ω : [3]

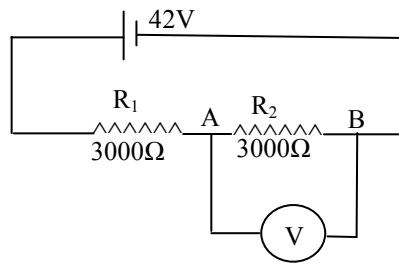


Figure 3

Question 3

- (a) Draw a labelled diagram of a potentiometer circuit used to measure internal resistance of a cell. In this experiment, what is the expression for the internal resistance 'r'? [3]
- (b) Apply Kirchoff's Laws to determine the currents I_1 and I_2 in the circuit shown in **Figure 4** below: [3]

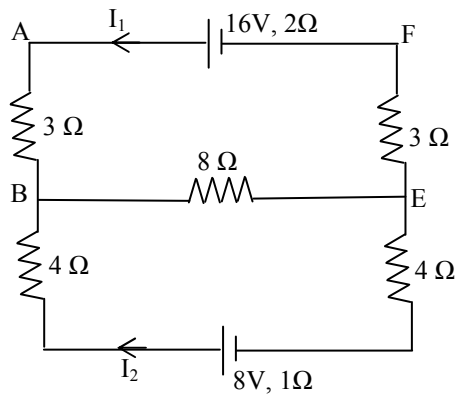


Figure 4

- (c) You are given a bar. How will you identify experimentally whether it is made of a ferro-magnetic, paramagnetic or a diamagnetic material? [3]

Question 4

- (a) Using Ampere's Circuital Law and with the help of a labelled diagram, show that magnetic flux density 'B' at a distance r from a long straight conductor is given by: [3]

$$B = \frac{\mu_0 I}{2\pi r}, \text{ where the terms have their usual meaning.}$$

- (b) Define 'time constant' of an LR circuit. What is its MKS unit? [2]

- (c) (i) In the circuit shown in **Figure 5** below, calculate phase difference between the current and the supply voltage: [4]

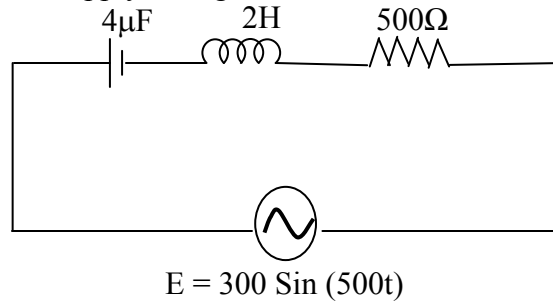


Figure 5

- (ii) What is meant by the term *band width* of an LCR circuit?

SECTION B

Answer any two questions

Question 5

- (a) With reference to radio wave communication, explain the terms: [2]
- (i) Amplitude modulation
 - (ii) Frequency modulation
- (b) In Young's double slit experiment, using light of wavelength 600 nm, 10th bright fringe is obtained on a screen, 3mm from the centre of the pattern. If the screen is 120 cms away from the slits, calculate: [3]
- (i) Distance between the two slits
 - (ii) Fringe width, i.e. fringe separation.
- (c) What is meant by *diffraction of light*? What is an *optical grating*? State its use. [3]

Question 6

- (a) A ray of light, LM, incident **normally** on one face AB of a prism ABC having refracting angle $A = 50^\circ$ grazes the adjacent face AC (See **Figure 6** below). What is the refractive index of its material? [2]

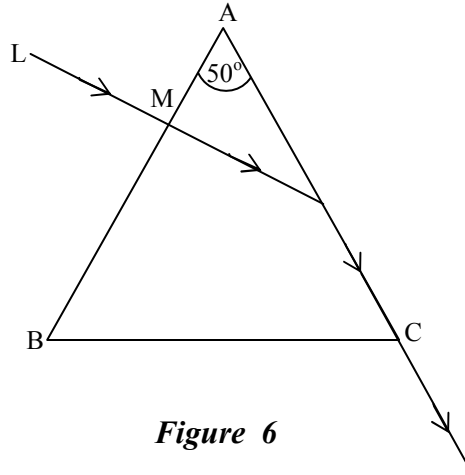


Figure 6

- (b) A convex spherical surface having radius of curvature of 20cm separates air from glass. [3]
) When a point object 'O' is kept in air, on its axis, at a distance of 50 cm from its pole, (see **Figure 7**), a real image 'I' is formed in glass at 300 cm from the pole P. Calculate the refractive index of glass.

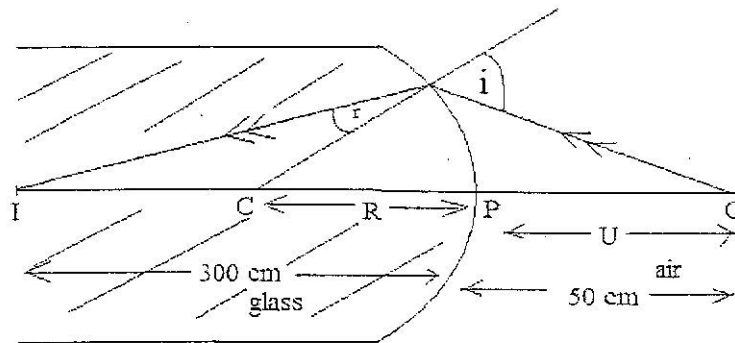


Figure 7

- (c) An optical system consists of a thin convex lens 'L' of focal length $f = 15$ cm and a convex mirror **M** having radius of curvature $R = 36$ cm, arranged co-axially at a distance of 24 cm. (See **Figure 8** below). [3]

Where should an object **O** be kept so that its inverted image **I** formed by the lens mirror combination coincides with the object itself?

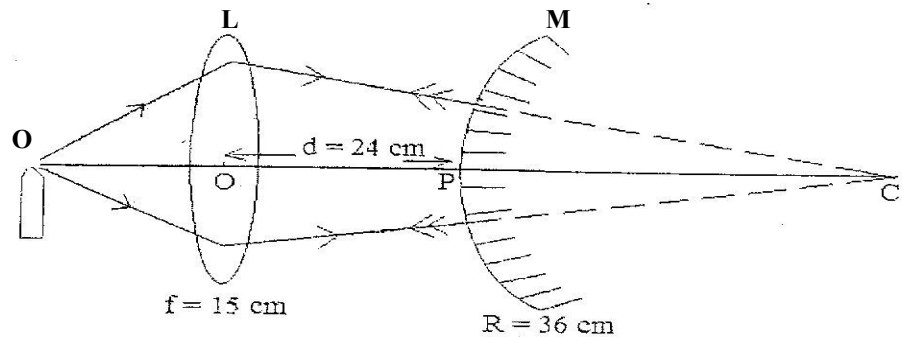


Figure 8

Question 7

- (a) A narrow and parallel beam of white light is incident on a convex lens, parallel to its principal axis. Draw a labelled diagram to show how coloured images are formed by the lens. [2]
- (b) Find the distance between the two lenses of a Compound Microscope if the final image formed by the microscope is virtual and lies at a distance of 25 cm to the left of the eye-piece. Magnifying power of the microscope is 30 and focal lengths of objective and eyepiece are 2cm and 5cm, respectively. [4]
- (c) You are provided with two convex lenses having focal lengths 4 cm and 80 cm, respectively, to form an astronomical telescope. [2]
- (i) Which lens would you use as an objective of an astronomical telescope and which one as an eyepiece?
 - (ii) If the telescope is in normal adjustment, what is its:
 - (1) Magnifying power?
 - (2) Length?

SECTION C

Answer any **two** questions.

Question 8

- (a) An electron is passed through a potential difference of 400 V. [3]
- (i) Calculate the speed acquired by the electron.
- (ii) If it enters a transverse and uniform magnetic field, what is the nature of the path described by the electron?
- (b) (i) Explain the statement: “**Work function** of a certain metal is 2.0 eV.” [3]
- (ii) Calculate the maximum wavelength of electro-magnetic radiation which will cause photo emission from this metal.
- (c) What is *de Broglie hypothesis*? What conclusion can be drawn from **Davisson and Germer’s experiment**? [2]

Question 9

- (a) **Figure 9** below shows a simple diagram of a modern X ray tube. (i.e. **Coolidge tube**). [3]

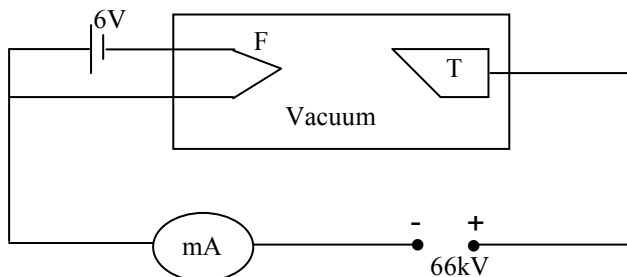


Figure 9

- (i) Find the *minimum* wavelength of the X rays emitted by the X ray tube.
- (ii) What will be the effect of replacing the 6 V battery by a 9 V battery on the emitted X rays?
- (b) What is meant by *mass defect* of a nucleus? How is it related to its binding energy? [2]
- (c) Starting with the Law of Radioactive Disintegration, show that: [3]
 $N = N_0 e^{-\lambda t}$, where the terms have their usual meaning.

Question 10

- (a) Calculate the energy released in the following nuclear reaction: [3]
 ${}^2_1\text{H} + {}^2_1\text{H} = {}^4_2\text{He}$
Mass of H = 2.01419 u, Mass of He = 4.00277 u
- (b) Draw a labelled circuit diagram of an arrangement used to study characteristic curves of a **PNP** or an **NPN** transistor in common emitter mode. [3]
- (c) What is the symbol of a **NAND** gate? Write its truth table. [2]

Useful Constants and Relations:

- | | | |
|-----------------------------|--------------|---|
| 1. Planck's constant | (h) | = 6.6×10^{-34} Js |
| 2. Speed of Light in vacuum | (c) | = 3.0×10^8 ms ⁻¹ |
| 3. Charge of an electron | (-e) | = 1.6×10^{-19} C |
| 4. Mass of an electron | m_e | = 9.0×10^{-31} kg |
| | ϵ_0 | = 8.85×10^{-12} Fm ⁻¹ |
| | 1eV | = 1.6×10^{-19} J |
| | 1u | = 931 MeV |
| | π | = 3.14 |

PHYSICS
PAPER – 2
(PRACTICAL)
(Three hours)

*(Candidates are allowed additional 15 minutes for **only** reading the paper.
They must **NOT** start writing during this time.)*

**ALL ANSWERS MUST BE WRITTEN IN THE ANSWER BOOKLET
PROVIDED SEPARATELY.**

If squared paper is used, it must be attached to the answer booklet.

*Marks are given for a clear record of observations actually made, for their suitability
and accuracy, and for the use made of them.*

*A brief statement of the method may be given if necessary. The theory of the
experiment is not required unless specifically asked for.*

Candidates are advised to record their observations as soon as they have been made.

*All working, including rough work, should be done on the same sheet as, and adjacent to, the
rest of the answer.*

*Mathematical tables and squared paper are provided. The intended marks for questions
or parts of questions are given in brackets [].*

*Answer **all** questions.*

You should not spend more than one and a half hours on Question 1.

Question 1

[10]

This experiment determines the focal length of a convex lens by the displacement method.

Determine the approximate focal length f of the given convex lens (marked M) by projecting the image of a distant object on a wall or a screen. Record the value of f in cm.

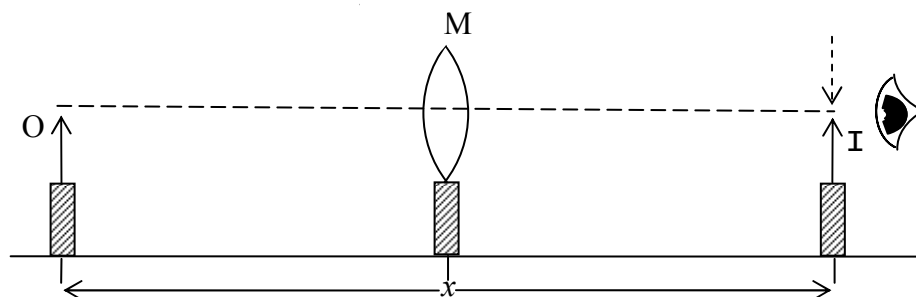


Figure 1(a)

Now arrange the object pin O, the image pin I and the lens M on the optical bench or table top as shown in **Figure 1(a)** so that the tips of O and I lie on the principal axis of the lens.

Adjust the distance x between O and I to be equal to 70 cm. Ensure that this separation is maintained throughout this particular set up.

Move the convex lens towards the pin I and adjust its position until the diminished and inverted image of O coincides with the image pin I. Record the position M_1 of the lens on the metre scale. **Show this reading to the Visiting Examiner.**

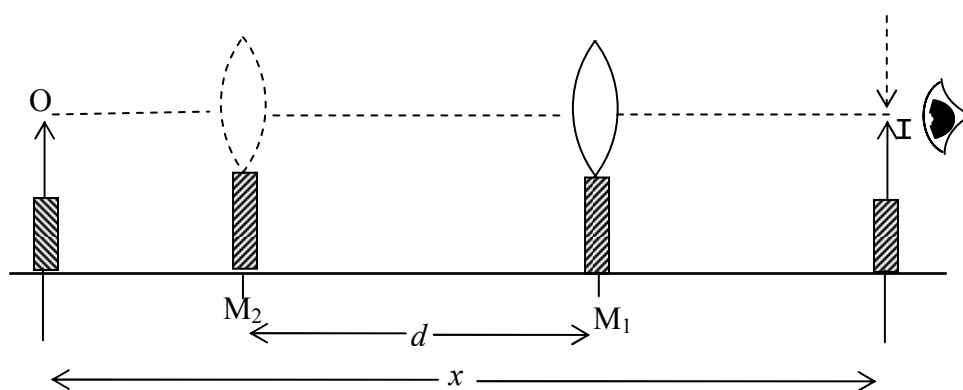


Figure 1(b)

Now move the lens towards the object pin O and adjust its position as shown in **Figure 1(b)** until the magnified and inverted image of O coincides with I. Record the new position M_2 of the lens. The difference between the two positions M_1 and M_2 is the displacement of the lens. Calculate the value of d .

Repeat the experiment to obtain four more sets of x and d where the range of x is between 70 cm and 100.0 cm.

Note that for each set, the positions of O and I are kept constant and M_1 and M_2 positions are obtained by moving the lens M only.

Tabulate the five sets of values of x , x^2 , d , d^2 and $y = \frac{x^2 - d^2}{100}$. Compute y upto three significant figures only.

Plot a graph y against x . Draw the line of best fit and determine its slope $S = \frac{\Delta y}{\Delta x}$.

Calculate the focal length F upto one decimal place, where $F = 25 \times S$.

Question 2

[7]

This experiment determines resistivity of the material of a wire. You are provided with a 1 m long uniform wire AB stretched along a metre scale and provided with binding terminals at the two ends. You are also provided with a resistance box RB, a piece of wire 'P' wound on a wooden bobbin and provided with binding terminals, a jockey 'J', a 2 V d.c. power supply (E), a plug key 'K', a centre-zero galvanometer 'G' and a few connecting wires.

Now set up the circuit as shown in **Figure 2** below. Ensure that all connections are tight.

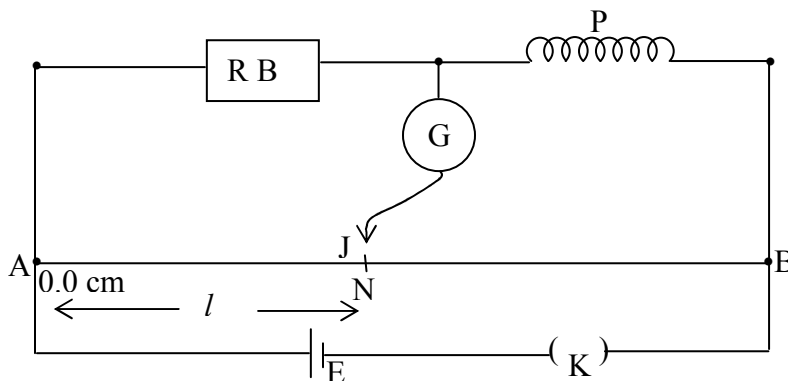


Figure 2

Take out $R = 1\Omega$ plug from the resistance box RB. By touching the jockey at various points on the wire AB, find the null point N for which the galvanometer shows no deflection. Record $l = AN$ in cm. **Show this reading to the Visiting Examiner.**

Repeat the experiment for *five* more values of R in the range $1\Omega - 10\Omega$, each time finding and recording the value of l .

Tabulate the values of R , l and $y = \frac{100 R}{l}$. Compute y upto one decimal place.

Plot a graph of y vs R and draw the line of best fit. Determine the slope S of the line using $S = \frac{\text{Change in } y}{\text{Change in } R}$.

Record the value of S upto three significant figures. From the graph, read and record the value Y_0 of Y when $R = 0$.

Question 3

[3]

Find the least count of the given micro meter screw gauge. Using it, determine the diameter 'D' of the sample wire 'W'. Record its value in your answer book in mm. **Show your reading of the screw gauge to the visiting examiner.**

Then find the radius r of the wire in cm. Using this value of r and the value of Y_0 of Question 2, find the value of K where:

$$K = \pi r^2 Y_0 \times 10^4.$$

Question 4

Show the following to the Visiting Examiner for assessment:

- (a) Project [7]
- (b) Physics Practical File. [3]