

PHYSICS PAPER 2 (PRACTICAL)

Answer **all** questions.

You should not spend more than one and a half hours on each question.

Question 1

[12]

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

You are provided with:

- (a) A lens holder
- (b) A convex lens
- (c) Two optical pins
- (d) An optical bench

Note: *The experiment may be performed on a table top, using a metre scale, in case an optical bench is not available.*

- (i) Determine the approximate focal length f of the given convex lens by projecting the image of a distant object on a wall or a screen. Record the value of f in cm, correct upto **one decimal place**.
- (ii) Now, arrange the object pin **O**, the image pin **I** and the lens **L** 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.

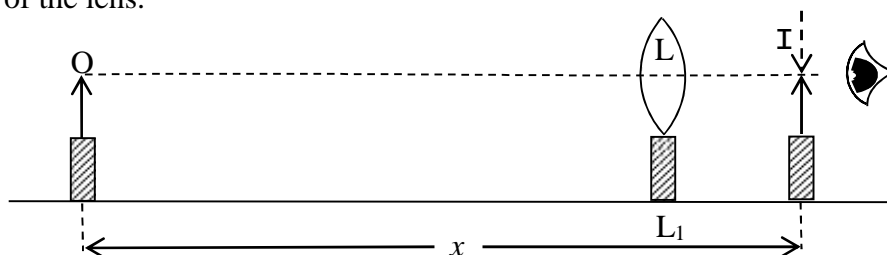
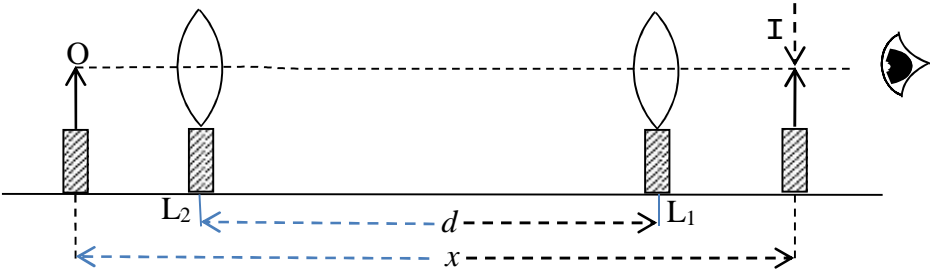


Figure 1(a)

- (iii) Adjust the distance x between **O** and **I** to be **nearly** equal to $(4f + 10)$ cm. Ensure that this separation is maintained throughout this particular setting.
- (iv) Move the lens towards the pin **I** and adjust its position until the diminished and inverted image of **O** coincides with the image pin **I**.
- (v) Read and record the positions of **O**, **L₁** and **I** on the metre scale in cm, correct upto **one decimal place**.

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| (vi) | <p>Keeping O and I fixed, 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 L₂ of the lens.</p> |
| |  <p style="text-align: center;">Figure 1(b)</p> |
| (vii) | <p>The difference between the two positions L₁ and L₂ of the lens is the displacement d of the lens. Calculate and record the value of d, in cm, correct upto one decimal place.</p> |
| (viii) | <p>Repeat the experiment to obtain four more sets of x and d, taking values of x in the range $(4f + 10)$ cm and 100 cm. Note that for each set, the positions of O and I are maintained constant and the parallax is removed by moving the lens only.</p> |
| (ix) | <p>Show the image position when the parallax has been removed, in any one of the readings in (viii) above, to the Visiting Examiner.</p> |
| (x) | <p>Tabulate all the five sets of values of x, x², d, d², and $y = (x^2 - d^2)/100$, along with their units given at each column head. Compute y up to three significant figures.</p> |
| (xi) | <p>Plot a graph of y against x. Draw the line of best fit and determine its slope S using:</p> $S = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\text{change in } y}{\text{change in } x}$ |
| (xii) | <p>Calculate the focal length F of the given lens correct up to one decimal place, using: F = 25 S.</p> |
| (xiii) | <p>Record the value of F in your answer booklet.</p> |

Comments of Examiners

Common errors made by candidates in attempting this question were as follows:

RECORD:

- Proper trend (x proportional to d) was not followed in a few cases.
- Many candidates did not express approximate focal length of convex lens correct upto 1 d.p and with unit.
- ‘ d ’, ‘ x ’ and ‘ y ’ were not recorded in a few cases.
- A few candidates obtained the value of $d > x$ because of which calculation of y became negative.
- Many candidates took $x < (4f + 10)$ and many candidate took 50 cm as a constant value.
- Some candidates made the mistake of rounding off ‘ y ’ upto three significant figures.

GRAPH:

- A few candidates did not label the graph or labelled wrongly, some used a kink; in several cases, non-uniform and inconvenient scale was chosen.
- Many candidates did not plot correctly or marked blobs.
- A number of candidates were unable to make the best fit line.

DEDUCTION:

- Many candidates took plotted points for finding slope.
- Many candidates did not record the focal length of the lens upto one decimal point.

Suggestions for teachers

- Show students different instruments such as, the metre scale, Vernier callipers, screw gauge, ammeter, voltmeter, etc. and tell them to write the least count. Teach students how to write observations in consistence with the L.C of the instrument, with correct unit.
- Give special emphasis on measurement, unit, significant figures, etc., so that mistakes are minimised.
- Explain about parallax error and show students how to remove it.
- Give sufficient practice in graphical skills which include:
 - (i) Proper labelling with unit,
 - (ii) Marking of origin with two coordinates without kink,
 - (iii) Choice of a uniform and convenient scale (tell students about inconvenient scale, e.g. 1 div. = 0.3, 0.33, 0.67, 0.66 etc not to be taken)
 - (iv) Meaning of correct plotting
 - (v) Concept of best fit and how to draw the best fit line.
 - (vi) Determining the Slope (for slope take two unplotted points on the line that are widely separated.)
- Instruct students to read the question paper carefully and underline the important points in pencil.

MARKING SCHEME

Question 1.

RECORD (R)

A. Approximate focal length of the lens correct upto 1 dp. with unit.

B. Four correct sets of x and d

Note:

- Correct set means as x increases, d also increases
- Unit of x or d : cm.
- ‘ d ’ should be recorded upto 1 decimal place in at least three sets.

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| C. | Correct calculation of x^2 , d^2 and y in at least three sets; Rounded off y upto 3s.f |
| GRAPH (G) | |
| A. | Axes labelled correctly with or without units. The scale should be uniform, convenient, covering more than 50% of the graph paper. Origin may / may not be marked. Interchange of axes is allowed but kink is not allowed. |
| B. | Four correct plots |
| | Note: <ul style="list-style-type: none"> – Points must be sharp and encircled. A blob is not a point. – Correct plot means if the plotting points lie within $\pm 50\%$ of one of the smallest divisions on both the scale of actual position. |
| C. | Best fit line (thin and uniform) at least the line passes very close to the four points (even for blobs) or within five divisions / one cm. perpendicular distance on both sides of the line drawn. The line should be extended on both sides with respect to the four plots. |
| DEDUCTION (D) | |
| A. | Correct calculation of slope (S) of the best fit line using two distant points (separated 50% or more than that of the line drawn, taking at least one unplotted point. |
| B. | Correct calculation of F , with 1dp. |
| QUALITY (Q) | |
| Candidates $F=$ should be in the range 7.5cm F 12.5cm. | |

Question 2

[6+2]

- A. This experiment determines the **resistivity** of the material of the given wire.
- You are provided with a 100 cm long uniform metallic wire **AB** stretched along a metre scale and provided with terminals at both ends.
- You are also provided with a resistance box **R.B.**, a voltmeter of range 0-3V, an ammeter of range 0 - 1A, a 4V dc power supply '**E**', a plug key '**K**', a jockey '**J**' and a few connecting wires.

- (i) Determine and record the **least count** of the given voltmeter and the ammeter with proper units in your answer booklet.
- (ii) Set up a circuit as shown in **Figure 2** below. Make sure that all connections are tight.

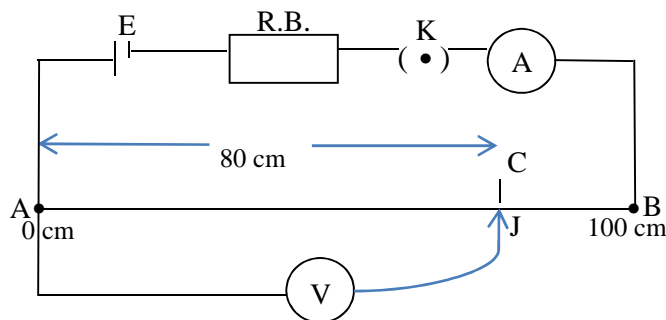


Figure 2

- (iii) Take out 1 plug from the resistance box R.B. so that $R = 1 \Omega$. Ensure that all other plugs are tightly closed. Place the jockey **J** at a point **C** on the wire **AB**, such that $AC = 80 \text{ cm}$. The reading of the voltmeter as well as the ammeter must be **within its range**. Read and record the readings of the voltmeter and the ammeter, i.e. **V** and **I**, with proper units.
- (iv) Repeat the experiment to obtain **four more** sets of readings of **R**, **V** and **I** by increasing the resistance **R** by 1Ω each time. Ensure that the jockey is **always** kept at the **same position C** such that $AC = 80 \text{ cm}$ in **all five sets** of readings.
- (v) **Show any one of the readings in (iv) above, to the Visiting Examiner.**
- (vi) Determine the value of resistance r using:

$$r = \frac{V}{I}$$

for each set, correct **upto three significant figures**.

- (vii) Now, tabulate all the **five sets** of values of **R**, **V**, **I** and **r** with proper units.
- (viii) Find r_0 , the mean of all the five values of r and record its value in your answer booklet.

- B.**
- (i) Determine and record the least count of the given **micrometer screw gauge** in **cm**.
 - (ii) Using it, calculate the diameter 'd' of the given specimen wire 'X' and record its value in **cm** in your answer booklet.
 - (iii) Calculate the **resistivity** ρ of the material of the wire, using the formula:

$$\rho = \frac{\pi d^2}{320} r_0$$

Comments of Examiners

Some errors made by candidates in attempting this question were as follows:

RECORD:

- Least counts of the ammeter and voltmeter were not recorded correctly by some candidates.
- The trends of R, V, and I were not correct in many cases.
- Several candidates did not record the values of V and I in consistence with the least counts of the instruments.
- Some candidates measured l and (100-l) instead of V and I.
- A few candidates recorded absurd values of voltage (e.g. 5V, 7V, 10V, 12V) and current.

DEDUCTION:

- Many candidates did not write $r = V/I$ correct up to three significant figures.
- In several cases, the mean value of r as r_0 was not calculated correctly or not shown at all.
- Record of L.C of screw gauge not written in cm.
- The value of diameter of the wire was not written in consistence with the L.C of screw gauge and also at times, without unit.
- Resistivity was not calculated in some cases or calculated incorrectly.

Suggestions for teachers

- Give practice to students in different electricity experiments and tell them the aim and trend of the experiment.
- Check practical record books of students regularly.
- Give more practice to students in recording the diameter of a wire using a screw gauge.
- Dimensions of different physical quantities must be explained
- Tell students to pay attention to the instructions given in the Question Paper.
- Give more practice to students in making calculations.

MARKING SCHEME

Question 2.

| | | |
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| A | RECORD (R) | |
| | L.C. of ammeter and voltmeter with their units. | |
| | Any four correct sets of R, V and I | |
| | Note: Correct set means: | |
| | (i) | As R increases, I decreases and V decreases |
| | (ii) | V and I recorded correctly in agreement with the L.C. of V and A respectively. |
| | DEDUCTION (D) | |
| | (i) | Correct calculation of r in at least 3 sets with unit. |
| B | (i) | Record of least count in cm and correct calculation of diameter 'd' (The unit cm should be present either in LC or in diameter. |
| | (ii) | Correct calculation of . |

GENERAL COMMENTS:

(a) Topics found difficult and confusing by candidates:

- Removal of parallax error.
- Concept of significant figures.
- Concept of Decimal place, rounding off upto proper decimal place.
- Significant figures, least count of instruments and writing of observations in consistence with the least count, with proper unit.
- Mention of correct unit of physical quantities.
- Graphical skills - proper choice of origin, uniform and convenient scale, proper labelling of the axes, meaning of correct plotting and concept of best fit line.
- How to find the slope from best fit line.

(b) Suggestions for candidates:

- Read the question carefully and follow the instructions, using only the formula given in the question paper for all the calculations.
- Ensure that all observations are consistent with L.C. of the measuring instrument and recorded in tabular form with unit. Note down the L.C. of the instruments used before starting the experiment.
- All values calculated should be calculated upto the decimal place or significant figures asked for the in the question.
- While doing any optical experiment with lens, always record the positions of object pin, image pin and the lens.
- Scale should be uniform and convenient with axes properly labelled.
- Origin should begin from zero if the intercept is to be found. Co-ordinates of the origin must be given/ marked on graph paper.
- Plots should be small encircled dots, correct to the nearest division of the graph sheet.
- Line of best fit means the aggregate of all plotted points drawn symmetrically and extended on both sides of the last plotted points.
- Slope calculation should be from two widely separated, unplotted points lying on the best fit line.
- The scale of the graph should be such that at least $\frac{2}{3}$ of the graph paper is used.