P510/3 EXAMINER'S COPY

PHYSICS

PAPER 3

July/ August 2023

ASSHU ANKOLE JOINT MOCK EXAMINATIONS 2023

Uganda Advanced Certificate of Education

PHYSICS PRACTICAL

Paper 3

3 hours 15 minutes

INSTRUCTIONS TO CANDIDATES

- *Answer Question 1 and* ***one*** *other Question.*
- *Candidates are* ***not*** *allowed to use the Apparatus for the first fifteen minutes.*
- *Graph papers are provided.*
- *Mathematical Tables and non-programmable*
- *Scientific Electronic Calculators may be used.*
- *Details on the Question Paper should not be repeated in the answer, nor is the theory of the experiment required unless specifically asked for.*
- *Candidates should, however record any special precautions they have taken and any particular feature of their method of going about the Experiment.*

1. In this experiment, you will determine the constant, **K** of the spiral spring provided and a property ∝ of the metre rule labelled ***Q***. **(40 marks)**

Part 1

(a) Balance the metre rule, **Q**, on a knife-edge with its graduated face upwards and note the position, **G**, of balance.

(b) Measure and record in metres the distance, ***X***, of the knife edge from hole, **H**.

(c) Pass an optical pin through the hole, H and then fix the pin into the rubber bung or cork provided.

(d) Clamp the rubber bung or cork.

(e) Attach a pointer, P_1, to one end of the spring provided.

(f) Suspend the spring from the rod of a clamp.

(g) Tie a pointer, P_2 firmly to the end, **B**, of the metre rule **Q** using a piece of thread.

(h) Tie the Free end of the spring to the metre rule at the **99.0 cm** mark as shown in Figure 1.

~~(i) Adjust the position of the clamp from which the spring is suspended until~~ the metre rule is horizontal.

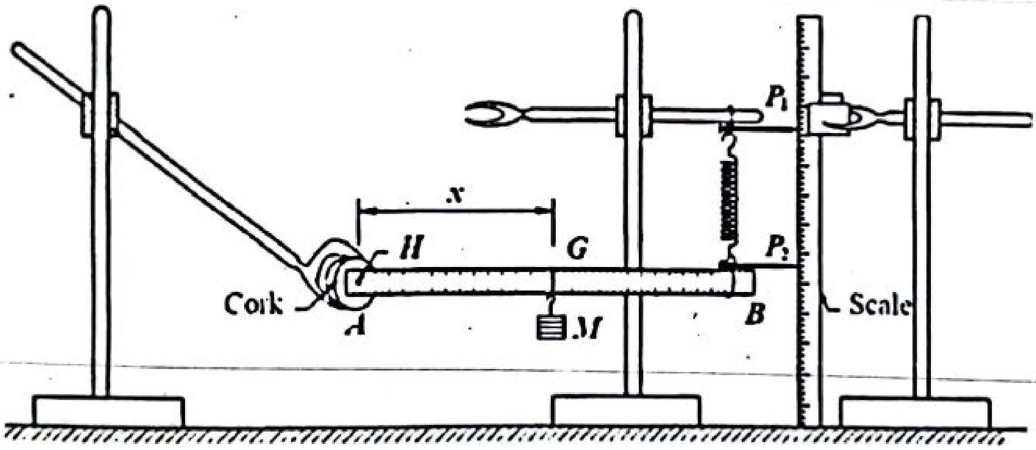

Fig. 1

(j) Clamp a metre rule vertically besides P_1 and P_2.

(k) Read and record the initial positions P_o and P_o^1 of pointers P_1 and P_2, respectively on the scale.

(l) Hang a mass M = 0.100 kg on metre rule Q, at a point G using a piece of thread.

(m) Adjust the position of the clamp from which the spring is suspended until P_2 returns to its initial position.

(n) Read and record the new position, P_1^1 of the spring in metres.

(o) Find the extension, $e = (P_1^1 - P_o)$ of the spring in metres.

(p) Repeat procedures (i) to (o) for values of **M** = 0.200, 0.300, 0.400, 0.500, and 0.600 kg.

(q) Tabulate your results.

(r) Plot a graph of e against **M**.

(s) Find the slope, S, of the graph.

(t) Find the intercept C on the e - axis.

(u) Determine the force constant, K_1, of the spring from the expression.

$$K_1 = \frac{xg}{0.98\,S}, \text{ where } g = 9.81ms^{-2}$$

(v) Determine the property $\propto_1$ of the metre rule Q from $\propto_1 = \frac{C}{S}$.

PART II

(a) Remove mass M

(b) Adjust the position of the clamp from which the spring is suspended until the metre rule Q is horizontal.

(c) Read and record the initial position of the pointers P_1 and P_2 as P_o and P_0^1

(d) Suspend a mass M = 0.300 kg at a distance y_1 = 30.0 cm from hole H.

(e) Adjust the position of the clamp from which the spring is suspended until the pointer P_2 returns to its initial position.

(f) Read and record the new position, P_1^1, of the pointer P_1 on the scale.

(g) Find the extension $e_1 = (P_1^1 - P_o)$ of the spring.

(h) Repeat procedures (d) to (g) for value of y_2 = 70.0 cm and record the new extension e_2.

(i) Determine the constant, K_2 of the spring from the expression

$$K_2 = \frac{3(y_2 - y_1)}{(e_2 - e_1)}$$

(j) Find K from the expression

$$K = \frac{1}{2}(K_1 + K_2)$$

(k) Determine the property $\propto_2$ of the metre rule Q from the expression

$$\alpha_2 = \frac{0.98}{x}\left[K\,e_1 - 3y_1\right]$$

(l) Find $\propto$ from the expression.

$$\alpha = \frac{1}{2}(\alpha_1 + \alpha_2)$$

(m) State two sources of errors in determining K and α.

Dismantle your set up.

2. In this experiment, you will determine the properties f_d and γ_d of a lens labelled D by two methods. (40 marks)

Method I

(a) Fix the lens labelled P in a lens holder.
(b) Focus a distance object onto a screen using the lens.
(c) Measure and record the distance, f, between the lens and the screen.
(d) Fix lens P and lens D together using small pieces of clear sellotape at the edges to form a composite lens.
(e) Fix the composite lens into a holder.
(f) Focus a distant object with the side of lens P facing the distant object.
(g) Measure and record the distance, F_1, between the composite lens and the screen.
(h) Arrange the object, screen with wire gauze, torch bulb, composite lens and the plane mirror as shown in Figure 2.

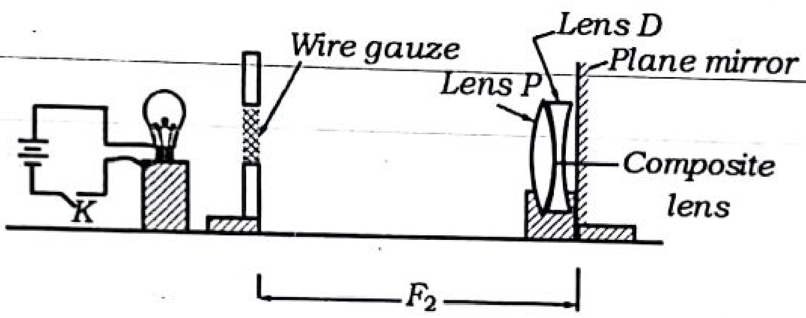

Fig.2

(i) Close switch K.
(j) Adjust the position of the Composite lens until a clear sharp image is formed on the screen.
(k) Measure and record the distance, F_2, between the object screen and the plane mirror.
(l) Open switch K.
(m) Find the value of $F = \frac{F_1+F_2}{2}$
(n) Calculate the value of f_d' from the expression

$$f_d' = \frac{Ff}{f-F}$$

Method II

(a) Arrange the Composite lens between the screen and wire gauze and connect the circuit shown in figure 3.

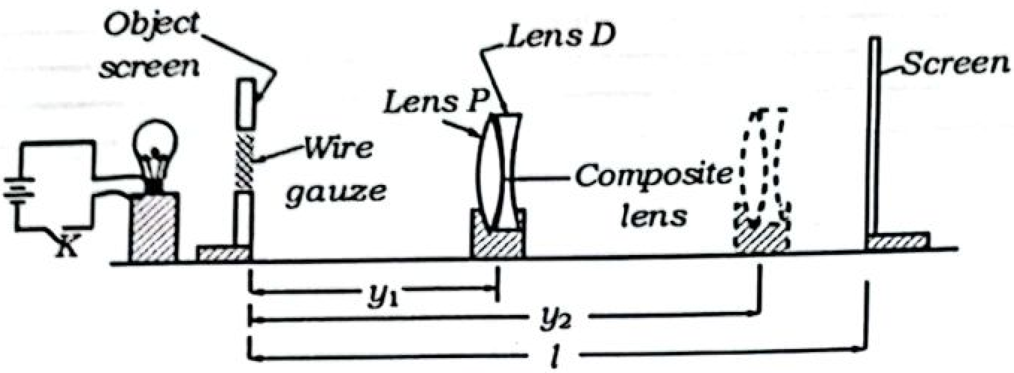

Fig 3

(b) Adjust the position of the screen such that it is at a distance of $l = 105.0$ cm from the object screen.

(c) Close switch K.

(d) Starting with the composite lens close to the wire gauze, move the lens towards the screen to obtain a clear image on the screen.

(e) Measure and record distance, y_1.

(f) Move the lens closer to the screen until a clear sharp diminished image is formed on the screen.

(g) Measure and record the distance y_2.

(h) Calculate the value of $d = y_2 - y_1$

(i) Open switch K

(j) Repeat procedures (b) to (h) for values of l =110.0, 115.0, 120.0, 125.0 and 130.0 cm.

(k) Record your results in a suitable table including values of $\frac{d^2}{l}$

(l) Plot a graph of l against $\frac{d^2}{l}$

(m) Read and record the intercept, C on the l-axis.

(n) Calculate the value f_d'' from the expression.

$$f_d'' = \frac{fC}{4f - C}$$

(o) Find the value of the property f_d of lens D, from the expression;

$$f_d = \frac{f_d' + f_d''}{2}$$

(p) State two ways in which the accuracy of f_d can be improved.

(q) Calculate the property γ_d of lens D, from $\gamma_d = \frac{1}{f_d}$

(r) State the meaning of γ_d and define it.

DISMANTLE THE SET-UP

Y

3. In this experiment, you will determine the constant λ, of the wire labelled W by two methods. (40 marks)

Method I

(a) Measure and record the diameter d in metres of the wire W.

(b) Starting with length, $x = 0.200$ m of wire W, connect the circuit as shown in figure 4.

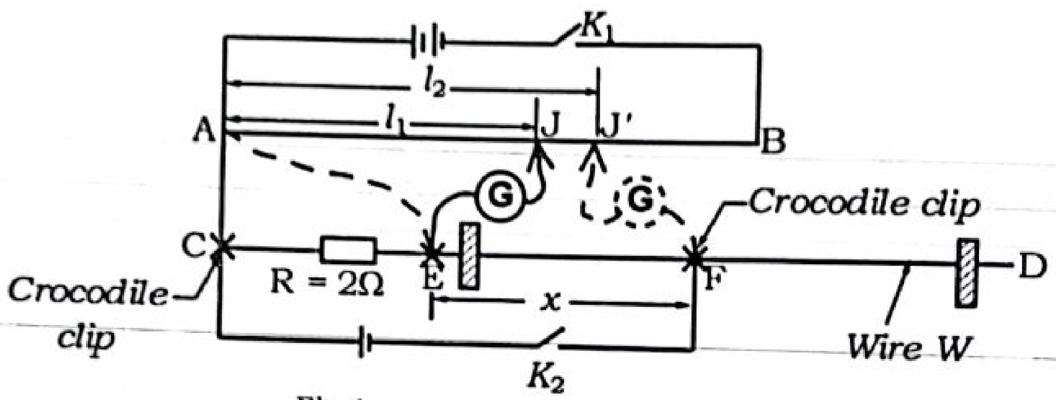

Fig.4

(c) Close switches K_1 and K_2

(d) Move the sliding contact along the potentiometer slide wire AB, to locate a Point J for which the centre – zero galvanometer shows no deflection.

(e) Measure and record the balance length l_1 in metres.

(f) Open switches K_1 and K_2

(g) Repeat the procedure from (b) to (f) for values of $x = 0.300$, 0.400, 0.500, 0.600 and 0.700 m.

(h) Disconnect A from C and connect it to E.

(i) Disconnect the galvanometer from E, and connected it to F as shown by dotted lines (connections) in figure 4.

(j) Starting with a length $x = 0.200$ m, close switches K_1 and K_2

(k) Move the sliding contact along the potentiometer slide wire AB to locate a point J′ for which the centre – zero galvanometer G, shows no deflection.

(l) Measure and record the balance length l_2 in metres

(m) Open switches K_1 and K_2.

(n) Repeat procedures (j) to (m) for values of x = 0.300, 0.400, 0.500, 0.600 and 0.700 m,

(o) Tabulate your results including values of $\frac{l_1}{l_2}$ and $\frac{1}{x}$

(p) Plot a graph of $\frac{I_1}{I_2}$ against $\frac{1}{x}$

(q) Find the slope S of the graph.

(r) Calculate the property λ_1 , of the material of wire W from the expression.

$$\lambda_1 = \frac{\pi d^2}{2\,S}$$

Method II

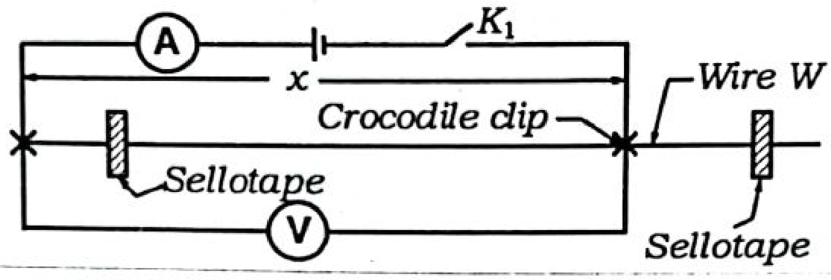

Fig.5

(a) Connect the circuit shown in figure 5 with length $x = x_1 = 0.350$ m of wire W.

(b) Close switch K_1

(c) Read and record the ammeter reading I_1, and voltmeter reading V_1.

(d) Open Switch K_1

(e) Change the position of the crocodile clip so that the length $x = x_2 = 0.850$ m of wire W.

(f) Read and record the ammeter reading I_2 and voltmeter reading V_2

(h) Calculate the constant λ_2 of the material of wire W from the expression.

$$2\lambda_2 = \frac{\pi\, d^2}{4}\left[\frac{I_2 V_1 x_2 + I_1 V_2 x_1}{I_1 I_2 x_1 x_2}\right]$$

(i) Calculate the constant λ of the material of wire W from the expression $2\,\lambda = \lambda_1 + \lambda_2$

(j) State the meaning of the constant λ

(k) Explain briefly two sources of errors that you may have encountered during the experiment.

DISMANTLE THE SET-UP.

END

PS1013

PHY

MARKING GUIDE

Question 1

A_1 Value of $C = 49.0 - 51.0$ cm 1dp in cm or $C = 0.490 - 0.510$ 3dp in m unit; cm. $\frac{1}{2}+\frac{1}{2}$

A_2 Value of $x = 0.480 - 0.500$, 3dp unit m, $\frac{1}{2}+\frac{1}{2}$

A_3 Value of P_0, 1dp in cm or 3dp in m, unit cm $\frac{1}{2}+\frac{1}{2}$

A_4 Value of P_0', 1dp in cm or 3dp in m unit cm $\frac{1}{2}+\frac{1}{2}$

~~[illegible]~~ A_5 - Value of P_1' in cm (1dp) and 3dp(m) — 01

A_7 - ~~A_5~~ Columnar table labelled; M, P_1, e. A_6 - Value of e in m — 01 $1\frac{1}{2}$ ~~A_5 — 01~~

Correct Symbols, @ $\frac{1}{2}$ $1\frac{1}{2}$

A_8 - ~~A_6~~ Indication of units using brackets (kg), ~~(cm)~~ m, (m) Correct Symbols, @ $\frac{1}{2}$ $1\frac{1}{2}$

A_9 ~~A_7~~ Values P_1' 1dp in cm or 3dp in ~~cm~~ m, @ $\frac{1}{2}$ ~~03~~ 2

A_{10} - ~~A_8~~ Values of $B = 0.020 — 0.300$, 3dp, increasing differences between consecutive values 0.005 – 0.080

If all differences are ~~equal~~ constant, mark only first 3 values. @ 1 ~~06~~ 05

16

A_9

B_1 Title; A graph of e against M no units Correct Symbols $\frac{1}{2}$

B_2 Perpendicular axes drawn with arrows, correctly labelled i.e V/A e (m); H/A M(kg). [Correct Symbols] @ $\frac{1}{2}$ 1

B_3 V/AS uniform ~~axis~~ scale covers $\frac{1}{2}$ or more, starting values indicated, axis marked atleast 3 times. H/A, starting from 0, axis marked at least 3 times @ $\frac{1}{2}$ 1

B_4 Correctly ploted points using x or ⊙ [not *]. For multiple scales, consider first uniform scale only, if axes are not labelled, or reversed don't check. @ $\frac{1}{2}$ 03

B_5 Line of best fit drawn provided atleast 4 points are correctly plotted $\frac{1}{2}$

B_6 Indication for slope S cover $\frac{1}{2}$ a page on at least one of the sides. $\frac{1}{2}$

B7 Correctly Calculated Slope S = 0.060 – 0.300
2dp or 3dps [Correct Symbols] unit : mkg^{-1} | $1 + \frac{1}{2}$

B8 Correctly Calculated Intercept – [Provided H/A starts from zero] C = 0.0080 – 0.0250
3dps or 4dps; unit : m | $\frac{1}{2} + \frac{1}{2}$

B9 Correctly Calculated value of K_1 = 20.0 – 60.0
0dp or 1dp [Provided Correct Substitution in $K_1 = \frac{xg}{0.985}$] unit : Nm^{-1} | $\frac{1}{2} + \frac{1}{2}$

B10 ~~Value~~ Correctly Calculated value of α_1 = 0.080 – 0.180, 2dps or 3dps
[Provided Correct Substitution in $\alpha_1 = \frac{C}{S}$] unit kg | $\frac{1}{2} + \frac{1}{2}$

| 11 |

D1 Value of P_0 1dp in cm or 3dp in m unit, cm | $\frac{1}{2} + \frac{1}{2}$

D2 Value of P_0' 1dp in cm or 3dp in m unit, cm | $\frac{1}{2} + \frac{1}{2}$

D3 Value of P_1', 1dp in cm or 3dp in m unit, cm | $\frac{1}{2} + \frac{1}{2}$

D4 Value of e_1; 1dp in cm or 3dp in m unit, cm | $\frac{1}{2} + \frac{1}{2}$ No range given for "e"

D5 Value of P_1'', 1dp in cm or 3dp in m unit, cm | $\frac{1}{2} + \frac{1}{2}$

D6 Value of e_2; 1dp in cm or 3dp in m unit, cm | $\frac{1}{2} + \frac{1}{2}$

D7 Value of K_2 = 20.0 – 60.0, 0dp or 1dp
[Provided Correct Substitution in $K_2 = \frac{3(y_2 - y_1)}{e_2 - e_1}$] No penalty for not indicating unit.
Unit Nm^{-1} | $1 + \frac{1}{2}$

D8 Value of K = 20.0 – 60.0, 0dp or 1dp
Provided Correct Substitution in $K = \frac{1}{2}(K_1 + K_2)$
Unit Nm^{-1} | $\frac{1}{2} + \frac{1}{2}$

D9 Value of α_2 = 0.080 – 0.180, 2dps or 3dps
[Provided Correct Substitution in $\alpha_2 = \frac{0.98}{x}[kg - 3y]$]
Correct Symbols, Unit kg | $1\frac{1}{2}$

D10 Value of α = 0.080 – 0.180, 2dps or 3dps
[Provided Correct Substitution in $\alpha = \frac{1}{2}(\alpha_1 + \alpha_2)$]
Correct Symbols, unit kg | $\frac{1}{2} + \frac{1}{2}$

D11 Sources of errors:
- Parallax errors in reading values from metre rule
- Zero errors in a metre rule
- Unstable retort stands ① 1 | 02
-

| 13 |

N.B pencil work no mark

Question 2 :-

A_1	Value of f = 8.0 − 14.0; 1dp, unit cm, [Correct Symbol]	$1+\frac{1}{2}$
A_2	Value of F_1 = 20.0 − 39.0, 1dp, unit: cm, [Correct Symbol]	$1+\frac{1}{2}$
A_3	Value of F_2 = 20.0 − 39.0, 1dp, unit: cm, [Correct Symbol]	$1+\frac{1}{2}$
A_4	Value of F = 20.0 − 39.0, 1dp, [Provided Correct Substitution in $F = \frac{F_1+F_2}{2}$], unit: cm [Correct Symbol]	$\frac{1}{2}+\frac{1}{2}$
A_5	Value of f_d' = −(13.0 − 22.0); 1dp [Provided Correct Substitution in: $f_d' = \frac{Ff}{f-F}$], unit: cm [Correct Symbols]	$\frac{1}{2}+\frac{1}{2}$
	N.B Pencil work, Zero marks	$6\frac{1}{2}$

B_1 — Value of y_1 in cm (1dp) − $\frac{1}{2}+\frac{1}{2}$ B_2 — Value of y_2 in cm (1dp) — $\frac{1}{2}+\frac{1}{2}$

B_3 — calculation of d in cm (1dp) — $\frac{1}{2}$

B_4 ~~B_1~~	Columnar table labelled: 1, y_1, y_2, d or (y_2-y_1) not $d=(y_2-y_1)$, d^2, $\frac{d^2}{l}$ (Correct Symbols) 6−5; $1\frac{1}{2}$, 4−3; 1, 2−1; $\frac{1}{2}$	$1\frac{1}{2}$
B_5 ~~B_2~~	Indication of units using brackets. (cm), (cm), (cm), (cm), (cm²), (cm) [Correct Symbols] 6−5; $1\frac{1}{2}$, 4−3; 1, 2−1; $\frac{1}{2}$	$1\frac{1}{2}$
B_6 ~~B_3~~	Values of y_1 = 50.0 − 20.0, 1dp, decreasing, differences between consecutive values 0.3 − 5.0 [If all Five differences are constants, mark only the first three values] @ 1	~~6~~ 5
B_7 ~~B_4~~	Values of y_2 = 40.0 − 121.0, 1dp, increasing, differences between consecutive values 3.0 − 11.0 [If all the five differences are constant, mark only the first three values] @ 1	~~6~~ 5
B_8 ~~B_5~~	Correctly Calculated values of d or y_2-y_1, 1dp; 6−5: $1\frac{1}{2}$, 4−3: ~~1~~ 0, 2−1; $\frac{1}{2}$	~~$1\frac{1}{2}$~~ 01
B_9 ~~B_6~~	Correctly Calculated values of d^2, 0dp, 6−5; $1\frac{1}{2}$, 4−3; 1, 2−1; $\frac{1}{2}$	$1\frac{1}{2}$
B_{10} ~~B_7~~	Correctly Calculated values of $\frac{d^2}{l}$, 1dp 6−5; $1\frac{1}{2}$, 4−3; 1, 2−1; $\frac{1}{2}$	$1\frac{1}{2}$
	N.B Pencil work, Zero marks	$19\frac{1}{2}$

C1 Title: A graph of l against $\frac{d^2}{I}$, no units [Correct Symbols] ½

C2 Perpendicular axes drawn, with arrows, Correctly labelled ie V/A: l (cm), H/A: $\frac{d^2}{I}$ (cm) [Correct Symbols] @ ½ 1

C3 V/A: uniform scale covers ½ or more, Starting values indicated, axis marked atleast 3times. H/A, starting value 0, axis marked atleast 3 times @ ½ 1

C4 Correctly plotted points using × or ⊙ [not ✱]. For multiple scales, Consider first uniform scale only. If axes are not labelled or reversed nomark @ ½ 3

C5 line of best fit drawn provided atleast 4 points are correctly ploted. ½

C6 Correctly read intercept C = 50.00 – 84.00, 0dp, or 1dp or 2dp [provided H/A starts from zero], unit: cm [Correct Symbols] 1½

7½

D1 Correctly Calculated Value of $f_d'' = -(13.0 - 22.0)$, 0dp or 1dp [provided Correct Substitution in $f_d'' = \frac{fc}{4f - c}$], unit; cm [Correct Symbols] ½ + ½

D2 Correctly Calculated Value of $f_d = -(13.0 - 22.0)$, 0dp or 1dp [provided Correct Substitution in $f_d = \frac{f_d' + f_d''}{2}$], unit cm, [Correct Symbols] ½ + ½

D3 – Determining the Value f_d using other methods

– Increasing number of decimal places for calculated values ~~obtained~~ to reduce errors in rounding off any two @ ½ 1

D4

D4 Correctly Calculated value of $\gamma_d = -(4.56 - 7.80)$ 1
1dp or 2dp [provided S.I substitution in
$\gamma_d = \frac{1}{f_d}$], unit D or dpt or dioptre, 1 + 1/2
[Correct Symbols]

D5 power of the lens; (meaning of γ_d) 1
D6 Definition of γ_d; reciprocal of the focal length. 1

6½

TOTAL 40

Question 3

A1 ~~Value~~ diameter d measured 3 times ½
A2 Value of $d = (0.00[illegible]5 - 0.00[illegible]7)$ 5dp unit m, 1+½
A5 Columnar table labelled; x, l_1, l_2, $\frac{1}{x}$, $\frac{l_1}{l_2}$
A3 Value of l_1 in m — 01 A4 — Value of l_2 in m — 01
(Correct Symbols) 5-4: 2, 3-2: 1, 1; ½ 2.
A6 A4 Indication of units using brackets, (m), l_1(m), l_2(m), $\frac{1}{x}$(m^{-1}), —, 5-4: 2, 3-2: 1, 1; ½ 2
A7 A5 Values of l_1 = 0.400 — 0.200, 3dp, ~~decreasing~~ decreasing, differences between consecutive values (0.030 — 0.120), [If all five differences are constants, mark only first three values] @ 1 ~~06~~ 5
A8 A6 Values of l_2 = 0.300 — 0.800, 3dp, ~~decreasing~~ increasing, differences between consecutive values 0.030 — 0.120, [If all five differences are constants, mark only first three values] @ 1 ~~06~~ 05
A9 A7 Correctly Calculated values of $\frac{l_1}{l_2}$, 2dps
6-5: ~~2~~ 1½ 4-3: 01½ 2-1; ½ ~~2~~ 1½
A10 A8 Correctly Calculated values of $\frac{1}{x}$, 2dps, (5.00, 3.33, 2.50, 2.00, 1.67, 1.43),
6-5: 1½ 4-3: 01½ 2-1: ½ ~~1~~ 1½ ~~22~~ 21

N.B Pencil work, No mark

B1 Title; A graph of $\frac{L_1}{L_2}$ against $\frac{1}{x}$, no units $\frac{1}{2}$

B2 Perpendicular axes drawn with arrows, Correctly labelled i.e V/A: $\frac{L_1}{L_2}$, H/A: $\frac{1}{x}$ (m^{-1}) [Correct Symbols] @ $\frac{1}{2}$ — 1

B3 Uniform Scales Cover $\frac{1}{2}$ or more, Starting values Indicated, axis marked at least 3 times — 1

B4 Correctly Plotted Points using x or ⊙ [not *]. For multiple scales, Consider first uniform scale only: If axes are not labelled or reversed no mark @ $\frac{1}{2}$ — 3

B5 Line of Best fit drawn. Provided at least 4 points are Correctly ploted. — $\frac{1}{2}$

B6 Indication for slope S Cover $\frac{1}{2}$ a page on atleast one of the Sides. — $\frac{1}{2}$

B7 Correctly Calcurated slope S = ~~0.0100 – 0.0300~~ ~~3dps~~ S = 0.100 – 0.400 2dps, or 3dps unit m — $1+\frac{1}{2}$

B8 Correctly Calcurated value of $\lambda_1 = (2.5 - 7.5) \times 10^{-7}$ 2sf; [Provided Correct Substitution in $\lambda_1 = \frac{\pi d^2}{2S}$] unit; Ωm [Correct symbols] — $1+\frac{1}{2}$

$9\frac{1}{2}$

C1 Value of $I_1 = (0.20 - 0.80)$, 2dp, unit, A — $1\frac{1}{2}$

C2 Value of $V_1 = (0.40 - 1.40)$, 1dp or 2dp, unit V, — $1\frac{1}{2}$

C3 Value of $I_2 = (0.20 - 0.80)$, $I_2 < I_1$, 2dp, unit A — $1\frac{1}{2}$

C4 Value of $V_2 = (0.40 - 1.40)$, $V_2 > V_1$; 1dp or 2dp; unit V, — $1\frac{1}{2}$

C5 Correctly Calcurated Value of $\lambda_2 = (2.5 - 7.5) \times 10^{-7}$ 2sf, [Provided correct substitution in $2\lambda_2 = \frac{\pi d^2}{4}\left[\frac{I_2 V_1 x_2 + I_1 V_2 x_1}{I_1 I_2 x_1 x_2}\right]$] unit Ωm — $1\frac{1}{2}$

C6 Correctly Calcurated values of $\lambda = (2.5 - 7.5) \times 10^{-7}$ [Provided Correct Substitution in $2\lambda = \lambda_1 + \lambda_2$], unit Ωm — $\frac{1}{2}+\frac{1}{2}$

C_7 Meaning of λ; "Resistivity of wire x," $\frac{1}{2}$

C_8 Sources of errors;

- Poor / Loose Connection at terminals
- The Potentiometer wire may not be 100cm.
- lack of uniformity in Potentiometer wire
- lack of uniformity in wire x
- Zero error in measuring l_1 and l_2
- Running down of dry cells
- Estimation of line of best fit any two @ $\frac{1}{2}$ 1

10

Total $40\frac{1}{2}$

Max $\overline{40}$