EXCEL IN O LEVEL PHYSICS PRACTICALS

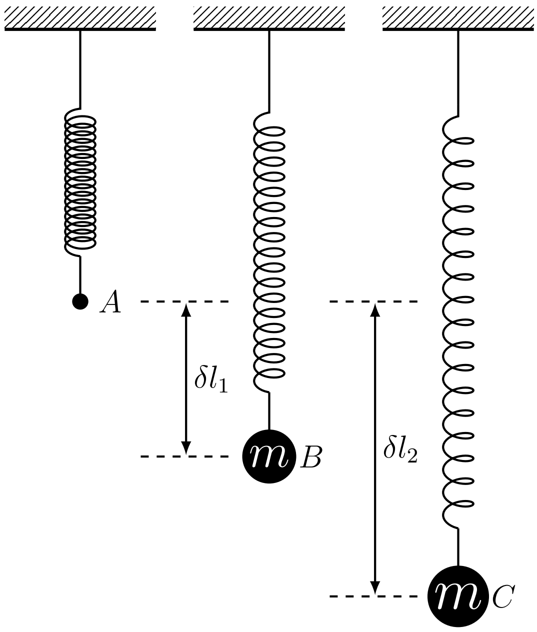

Figure 1: Extension of a spring when loaded(Hooke's law).

The book provides students with skills and techniques on

- *Reading measuring instruments*
- *Tabulation*
- *scales*
- *Graph work and plotting skills*
- *Significant figures,decimal places and rounding off*
- *Table work*

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Learn the physics practical skills at home

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Chapter 0

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Chapter 1

INTRODUCTION

Following the new changes that have been passed since 2018 ,i found it challenging that most of the students have not mastered the content.And with my research and consultations from the senior teachers i have decided to come out with this book that i hope will be helpful to both the teachers and the learners.Simple language has been used and key points are emphasized to help the learners excel with a distinction in practicals and in the paper at large.My major emphasis is the applicability of the knowledge that the students get from class and how they can apply it in daily life. Its quite intresting that most of the students have the knowledge and theoretical matter of the subject but lack the application.Therefore i urge my fellow physics teachers to help the learners in both the real life application of the subject and also encouraging them to take on the subject

1.0.1 Nature of the Physics practical

1 The paper is divided into three main parts.Mechanics, light,heat and electricity.The paper is done for $2\frac{1}{4}$hours.The first quarter of an hour candidates are not allowed to start working with the apparatus, but to manipulate and interprete the questions and probably make wise decisions on the choice of the questions to attempt.

2 Candidates are required to attempt two questions of which one is a compulsory number (mechanics) and one optional question either from light or electricity

3 The Paper is marked out of 60 marks were each number is carrying 30 marks.

1.0.2 Aims of the physics practicals

The practical course is to enable students to:

- Gain experience of a variety of measuring instruments,to learn how to handle them with skills and to appreciate their limitations
- Do experiments on the fundamental laws and principles encountered in the theoretical work

- To develop an inquisitive mind
- Draw conclusions from the observations made.

Tips of passing physics practicals

In order for a candidate to maximise well the practical examination he/she needs to have /do the following

- Read carefully all the questions in the paper and choose wisely the convenient question to start with.The candidate must understand the aim of the experiment
- Draw the sketch of the table of results before you start carrying out the experiment
- Arrange the apparatus as it appears on the question paper and carefully follow the procedures
- Identify the quantities to be measured from the procedures.Identify the quantities to be tabulated and their accompanying units

1.1 Current changes

- **Table of results**.Values MUST be presented in a column form.Both horizontal and vertical lines may be drawn.*Related values should be next to each other,with clearly labelled units*.e.g

V(V)	$V^2(V^2)$	I(A)
0.23		
0.28		

- Data MUST be entered in the table strictly using a pen
- When recording directly measured values(Experimental values),the unit attached must be the unit of the instrument used unless when required to record otherwise
- Writing of units MUST be done using a bracket not a forward slash e.g x(m) and not x/m
- The least count of a measuring instrument must dictate the level of accuracy(number of decimal places, to which a measured value must be recorded).e.g The least count of a metre rule is 0.1,therefore all values read from a metre rule must be recorded to 1 d.p
- Trigonometric functions of $\cos, \sin, \tan, \log,$ MUST be recorded to 3 d.ps.e.g $\cos 70 = 0.342$
- For reciprocals ,the largest value in the column ,determines the S.F of the processed values and fixes the number of d.p in the column.
- When obtaining a product or quotient of varying values in two columns i.e the largest product or quotient are to be used.The multiplication and division rules do apply(least S.F between the two values)

- During addition and subtraction of Values the d.ps of the least accurate value is to be used.e.g $4.2014(4d.p) + 5.4(1d.p) = 9.6(1d.p)$
- Thse scale Must be multiples or submultiples of $1, 2, 5$ and atworst 2.5

1.2 Measuring instruments and their accuracy

The smallest value that can be measured by the measuring instrument is called its least count. Measured values are good only up to this value. The least count error is the error associated with the resolution of the instrument
NOTE. *The least count of an instrument determines the number of decimal places to which the measured values are to be recorded.*

1. **Meter rule**
   A meter rule is one metre long and contains 100cm.It measures length to 1 d.p in centimetres.When required in metres its recorded to 3 d.ps.e.g *20.0cm,* and when required in metres *0.200m*

$$\begin{aligned} 10divisions =& 1.0cm \\ 1div =& \frac{1}{10} \\ 1div =& 0.1cm(1d.p) \end{aligned}$$

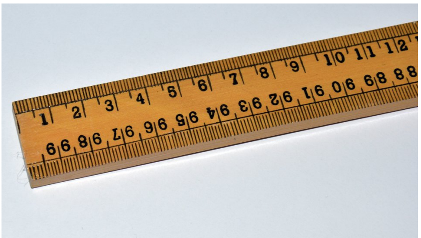


Figure 1.1: Meter rule

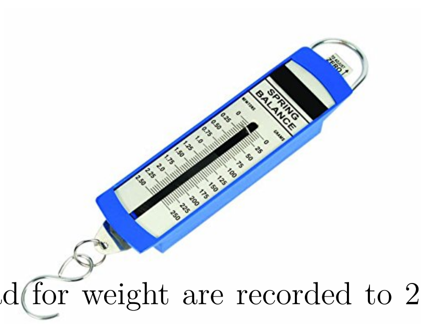
   least count for a metre rule =0.1cm.All values read from a metre rule are recorded to 1 d.p

2. **Spring balance**
   For measuring mass and weight of objects.It has a scale for measuring mass in grams(g) and weight in newtons(N)

Scale 1(Weight of the object)

Figure 1.2: Spring balance

$$\begin{aligned} 5divisions =& 0.25N \\ 1div =& \frac{0.25}{5} \\ 1div =& 0.05N(2d.p) \end{aligned}$$



least count for spring balance =0.05N.All values read for weight are recorded to 2 d.p e.g 0.56N

Scale 2(Mass of the object)

$$
\begin{aligned}
10divisions =& 25g \\
1div =& \frac{25}{10} \\
1div =& 2.5g(1d.p)
\end{aligned}
$$

least count for spring balance =2.5g.All values read for mass are recorded to 1 d.p e.g 24.5g

3. **Stop clock**
   For measuring time in seconds.its either to one d.p or 0 d.p.The time recorded to 1 d.p MUST have its last digit as a zero or five .e.g *20.5s,12.0s,34.5s*
   Type 1

$$
\begin{aligned}
10divisions =& 5s \\
1div =& \frac{5}{10} \\
1div =& 0.5s(1d.p)
\end{aligned}
$$

Figure 1.3: Stopclock.

least count for a stop clock=0.5s.All values read from such a stopclock are recorded to 1 d.p five .e.g *20.5s,12.0s,34.5s*
Type 2

$$
\begin{aligned}
5divisions =& 5s \\
1div =& \frac{5}{5} \\
1div =& 1s(0d.p)
\end{aligned}
$$

Figure 1.4: Stopclock

least count for a stop clock=1s.All values read from such a stopclock are recorded to 0 d.p e.g 12s,34s

4. **Stop Watch**
   For measuring time in seconds.its written to 2d.p.e.g *20.53s,12.04s,34.15s*

$$\begin{aligned} 100microseconds =& 1second \\ 1microsecond =& \frac{1}{100} \\ =& 0.01s(2d.p) \end{aligned}$$

Figure 1.5: Stopwatch.

least count for a stop watch =0.01s.All values read from a stopwatch are recorded to 2 d.p e.g 12.23s,34.12s

$$\begin{aligned} time =& t(hours) + t(minutes) + t(seconds) + t(microseconds) \\ =& 0(hours) + 01(minute) + 23(seconds) + 47(microseconds) \\ =& \frac{0}{60} + (1 \times 60) + (23) + \frac{47}{100} \\ =& 60 + 23 + 0.47 \\ =& 83.47s \end{aligned}$$

Figure 1.6: Stopwatch.

5. **Ammeters**
   For measuring current in amperes.There are of different scales and thus the number of decimal places depend on the least count.

$$\begin{aligned} 10divisions =& 0.2A \\ 1div =& \frac{0.2}{10} \\ 1div =& 0.02(2d.p) \end{aligned}$$

Figure 1.7: Ammeter.

least count for an ammeter =0.02A(2d.p).All values from such an ammeter are recorded to 2 d.p e.g 0.56A,0.40A

6. **Voltmeters**
   For measuring Voltage in volts.Currently there are a number of different voltmeters having differing scales,therefore the number of d.ps are determined by the leastcount of an instrument in use.

Type 1(Lower scale)

$$10divisions = 0.6V$$
$$1div = \frac{0.6}{10}$$
$$1div = 0.06(2d.p)$$

least count for a Voltmeter =0.06V(2d.p).All values from such a voltmeter are recorded to 2 d.p e.g 0.56V,0.40V

Type 2(Upper scale)

$$10divisions = 1V$$
$$1div = \frac{1}{10}$$
$$1div = 0.1(1d.p)$$

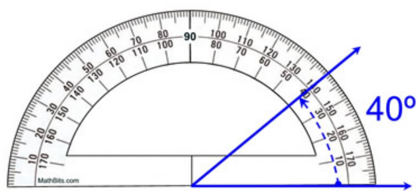
Figure 1.8: Voltmeter

least count for a Voltmeter =0.1V(1d.p).All values from such a voltmeter are recorded to 1 d.p e.g 0.5V,0.4V

7. **Protractor**
   For measuring angles in degrees.its written to 0 d.p.e.g 20^0

$$10divisions = 10^0$$
$$1div = \frac{10}{10}$$
$$1div = 1^0(0d.p)$$

Figure 1.9: Protractor



least count for a protractor $=1^0$.

1.2.1 Summary of the measuring instrruments

Instrument	Physical quantity	units and accuracy
metre rule	length	cm to 1d.p(leastcount =0.1(1d.p))
Voltemeter	voltage	V to 2d.p(leastcount=0.06V)and to 1d.p(leastcount=0.1V)
Ammeter	current	A to 2d.p(leastcount=0.02A)
stop watch	time	s to 2d.p(leastcount=0.01s)
stop clock	time	s to 1d.p (leastcount =0.5s)
potractor	angles	(^{0}) to 0 d.p(leastcount=1^0)

1.2.2 Treatment of values

This involves the rules governing data manipulation

(a) **Addition and subtraction rule**.
When adding or subtracting two quantities ,the value with the least number of decimal places is considered.e.g

(i) $4.7(1d.p) + 2.41(2d.p) = 7.1(1d.p)$ (we consider the least d.ps)

(ii) $4.21(2d.p) - 3.0(1d.p) = 1.2(1d.p)$

(b) **Multiplication and division rule**
when dealing with quotients and products of varying quantities the least number of significant figures of the two quantities is considered

1.2.3 Significant figures

Are digits in a number that are known with certainty plus the first digit that is uncertain.The Significant Figures of a number have meaning in reference to a measured or specified value. Correctly accounting for Significant Figures is paramount while performing arithmetic so that the resulting answers accurately represent numbers that have computational significance or value.

Rules governng significant figures

1. All non zero digits in a number are significant e.g 4362(4 S.F), 1241(4 S.F),1.26(3 S.F),1.2(2 S.F)

2. All zeroes occuring between non zero digits are significant.They are also known as trapped zeroes.e.g 1.004(4 S.F),1002(4S.F)

3. law of trailing zeroes:All zeroes to the right of the last non zero digit are

(i) significant if they are not as a result of rounding off.e.g 720(3 S.F)

(ii) Not significant if they are obtained as aresult of rounding off e.g 6259 to 3S.F is 6260(3S.F).so this zero is not significant

4. Zeroes before a non zero digit are not significant.They are known as leading zeroes.e.g 0.06(1S.F),0.000000054(2 S.F).

Therefore when multiplying and dividing quantities rules must be followed.

(a) $1.24(3sf) \times 1.8(2sf) = 2.2(2sf)$

(b) $1.045(4sf) \times 1.93(3sf) = 2.02(3sf)$

(c) $0.04(1sf) \times 1.2(2sf) = 0.05(1sf)$

(d) $\frac{1.43(3sf)}{1.2(2sf)} = 1.2(2sf)$

(e) $\frac{1.9(2sf) \times 2.40(3sf)}{(0.002(1sf)} = 2000$

Complete the following table by writing to the required number of significant figures

Digit	1s.f	2s.f	3s.f	4s.f	5s.f
0.786					
8.3257					
0.687432					
7.04423					
1.999978					
9.2346					
26					
0.002489					
56.987					

1.2.4 Float values(constant values)

These are values with an infinite number of significant figures and decimal places.when dealing with such values we ignore their significant figures and we consider the significant figures of the varying variables(measured values).e.g when dealing with oscillations $T = \frac{t}{n}$.for this case the S.F of the experimental value of t is considered.i.e E.V>F.V(Experimental value weigh more compared to float values)

1.2.5 Rounding off

For most measurements,finite figures are required.rounding off numbers creates numbers with fewer digits.During rounding off, if the digit to the right is $0, 1, 2, 3, 4$ the digit being rounded to remains the same.e,g 5.422 to 1d.p is 5.4.
If the digit to the right is $5, 6, 7, 8, 9$ the digit being rounded to increases by one e.g 5.46 to 1 d.p is 5.5
Complete the following table by collecting to a given number of decimal places

Digit	0 dp	1dp	2 dp	3dp	4 dp
0.3567856					
8.3257					
0.687432					
7.2301					
0.562789					
9.2346					
7.4466					
0.002489					
56.987					

1.2.6 Recording trigonometric functions

All trigonometric functions are recorded to 3 decimal places with no units.e.g $\sin, \cos, \tan, \log, In$
e.g $\cos 25 = 0.906$
$\sin 25 = 0.423$
$\tan 25 = 0.466$
$\log 25 = 1.398$

1.2.7 Recording roots of numbers

When dealing with square,cube,fourth roots,e.t.c of a number, they must be recorded to a finite number of decimal places.i.e Whole numbers are written to 3 d.ps.e.g
$\sqrt{\text{whole number}} = 3d.p$
$\sqrt{4} = 2.000$
$\sqrt{25} = 5.000$
$\sqrt[4]{56} = 2.736$
For numbers with decimal places, the significant figures of that number are considered
$\sqrt{4.0}(2sf) = 2.0$
$\sqrt{3.52}(3sf) = 1.88$
$\sqrt[3]{25.48}(4sf) = 2.943$

1.2.8 Symbols,Units and Handwriting

When dealing with practical work candidates must use the best handwriting possible in order for them to score highly.letter construction must be clear to candidates more so when writing numbers such as $2, 5, 7$. since the majority write,**s** instead of 5
Units that are named after scientists have their symbols written in capital letters and full names written in small letters.e.g

Name	symbol
amperes	A
volts	V
joules	J
newton	N
watts	W

Units that are not names of scientists have their symbols written in small letters

metres	m
centimetres	cm
grammes	g
seconds	s

1.2.9 Format of the practical report

1. Title/Aim of the experiment.e.g An experiment to determine the contant ,β of the convex lens

2. Table of results.For the observations and measurements carried out.

   Presentation of data in the main table of results
   The data entered in the table must be of varying quantities ,and therefore float values must be recorded outside this table.The order may be as below.

   - **Given values(G.V)**:These are values given in the procedure and they must not be altered.They are always recorded in the first column.
   - **Measured values(Experimental values)(E.V)**:These values are obtained from the measuring instrument and recorded to the level of accuracy of the instrument.They appear next to the given values
   - **Calculated values(C.V)**:These are derived from the experimental and given values.When recording these values the rules of addition,multiplication,division must be applied.*The number of decimal places must be consistent in a given column*

   Features of a good table

   - The table must be closed and in column form
   - Given values must come before experimental values
   - The physical quantities must be written well together with their units
   - Values must be presented in blue or black ink
   - The number of decimal places must be uniform in a particular column
   - The table must be neat and organized

3. Graph work
   Features of a good graph

   - The graph must have a centered title with no units e.g A graph of x against $\frac{x^2}{y}$,
     $\underline{\text{A graph of } x \text{ against } \frac{x^2}{y}}$ (In case you underline your title the line must not cut any of the letters.
     Such titles of the graph are not a warded. e.g
     Agraph of x against $\frac{x^2}{y}$(A is combined with g)
     A Graph of x against $\frac{x^2}{y}$ (Capital letter in the middle ,G)
   - Axes must be well labelled and demarkated with corresponding quantities and end points respectively.Demarkation points every after $2cm$
   - The scale choosen must be suitable ,convenient and must cover atleast $\frac{3}{4}$ of the full graph.
   - The graph must be drawn using a pen only

Scale

The convenient scale must be a multiple of $1, 2$,5 or other scales generated from their sub multiples.e.g 2.5
When going down you divide the multiples by 10 and when going up you multiply the multiples by 10

100	200	500	1000
10	20	50	100
1	2	5	10
0.1	0.2	0.5	1
0.01	0.02	0.05	0.1

Selection of a convenient scale
The choice of a scale depends on the values to be plotted.
Scale indicator
These shows us the range were our scale lies.We have two indicators,the Horizontal scale indicator(HSI)and the Vertical scale indicator(VSI)

$$\boxed{VSI = \frac{\text{largest value} - \text{smallest value}}{10}} \quad \boxed{HSI = \frac{\text{Largest value} - \text{smallest value}}{8}}$$

Steps for obtaining a convenient scale

step 1 Identify the largest(L) and smallest (S) value in the column to be plotted

step 2 Obtain the scale indicator

step 3 Round off the calculated value to a precise number of decimal places

step 4 Trace for the range where the calculated value lies among the scales

step 5 Take the largest of the two values where it lies and if its exact ,then just use it.

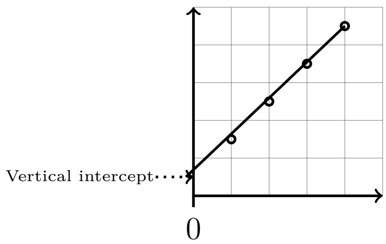
EXAMPLE

l(m)	y(m^2)
20,0	400
25.0	418
30.0	450
35.0	490
40.0	532
45.0	576
50.0	625

Vertical scale	Horizontal scale
step 1 Largest value=50.0 smallest value=20.0 **step 2**: $VSI = \frac{\text{largest value} - \text{smallest value}}{10}$ $= \frac{50.0 - 20.0}{10}$ $=3.00$ **step 4**:It lies between 2 and 5 therefore our scale will be Vertical scale :2cm:5	**step 1** Largest value=625 smallest value=400 **step 2**: $HSI = \frac{\text{largest value} - \text{smallest value}}{10}$ $= \frac{625 - 400}{8}$ $=28.13$ **step 4**:It lies between 20 and 50 therefore our scale will be Horizontal scale :2cm:50

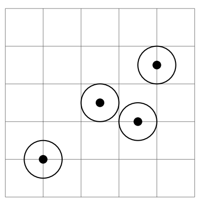
1.2.10 Intercept

For questions that involve obtaining intercept the adjacent axis must start from zero.i.e if an intercept is required on the $y-axis$(Vertical axis),then the $x-axis$(Horizontal axis) must start from zero and if an intercept is required on the $x-axis$(Horizontal axis),then the $y-axis$(vertical axis) must start from zero.If the intercept is required on both $x-axis$ and $y-axis$,then both axes must start from zero.
NOTE: *The starting point on each axis must be a multiple of the scale used.Each axis must have its own starting point*



1.2.11 Plotting the points

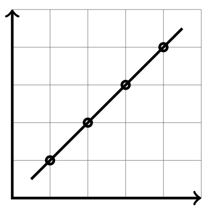
When plotting the coordinates,we either use a circle with a small dot, or an x covering 1 small square box



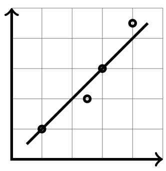
1.2.12 Line of best fit(Trend line)

A line of best fit (or "trend" line) is a straight line that best represents the data on a scatter plot. This line may pass through some of the points, none of the points, or all of the points. It has numerous definitions,which include

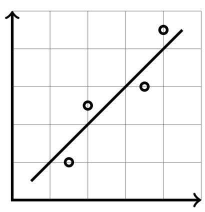
(i) It is the line which passes through all the plotted points.



(ii) It is a line which passes through most of the plotted points, but leaving an equal number on both sides

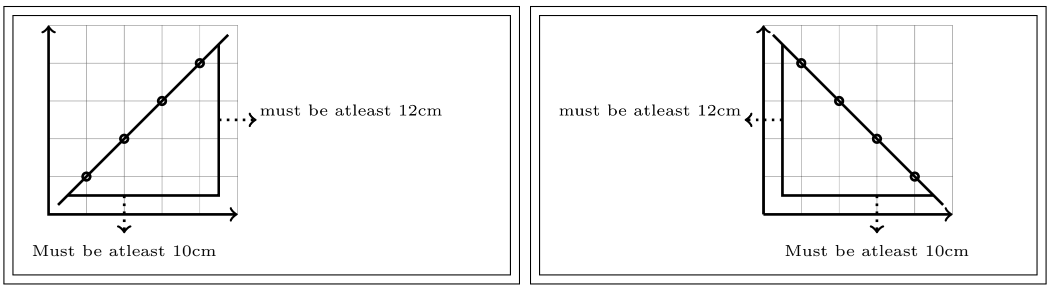


(iii) It is a line that doesnot pass through any of the plotted points ,but leaves an equal number on both sides



Slope

Slope is the change in the y coordinate divided by the corresponding change in the x coordinate, between two distinct points on the line. when obtaining a slope a Right Angled Triangle (RAT) is drawn enclosing all the plotted points.The values to be used must not be obtained from the plotted points,but must be coordinates ,lying on the line of best fit. *The RAT must be a solid line(not dotted) in ink*



Reading of values from the graph for the slope

When recording values,we consider the number of decimal places of one division(1 small square box).This is obtained by dividing our scale by 10 square box, to obtain one division.All values read from the graph must be recorded to the number of decimal places of one division.

$$\text{slope} = \frac{\text{Change in vertical axis(with units)}}{\text{Change in horizontal axis(with units)}}$$
$$= \frac{y_2 - y_1}{x_2 - x_1}$$

1.2.13 Recording and manipulation of Data in the table of results

Addition and subtraction
When obtaining derived quantities,involving addition and subtraction,the leading values in the column dictates the number of decimal places for the column.i.e The derived value must be written to the least number of decimal places from one of the two leading value.
Example

u(cm)	v(cm)	(u+v)(cm)	(u-v)(cm)
20.0	**19.5**	39.5	0.5
25.0	16.7	41.7	8.3
30.0	15.0	45.0	15.0
35.0	14.0	49.0	21.0
45.0	12.8	57.8	32.2
50.0	12.5	62.5	37.5

The leading value in the columns of u and v have 1 d.p and therefore our answers will be written to 1 d.p

Multiplication.
When dealing with multiplication of two varying columns,we take the following steps

Step 1 :Test the varying quantities,that gives you the largest product(in most cases the first and last values in the column gives the largest product)

Step 2 :Obtain the value writing it to the least number of significant figures between the two values

Step 3 :Fix the number of decimal places for the whole column basing on the largest product

u(cm)	v(cm)	UV(cm^2)
20.0	20.0	400
25.0	16.7	418
30.0	15.0	450
35.0	14.0	490
40.0	13.3	532
45.0	12.8	**576** (0 d.p)

The rest of the values must be written to 0 d.p after obtaining the largest product.

Division
When computing the derived quantity ,obtain the largest quotient of the two varying quantities(considering the least S.F between the two values) and use it to fix the number of decimal places for the column
Example
3.52 is the largest quotient so it fixes the rest to 2d.p

u(cm)	v(cm)	$\frac{\text{u}}{\text{v}}$
20.0	20.0	1.00
25.0	16.7	1.50
30.0	15.0	2.00
35.0	14.0	2.50
40.0	13.3	3.01
45.0	12.8	**3.52**

Reciprocals

Values of the nature.$\frac{1}{y}, \frac{1}{v}, \frac{1}{\text{x}}$ are obtained using the following steps

Step 1 :Identify the largest value in the column of the denominator

Step 2 :Obtain the calculated value basing on the S.F of the largest value in the column of the denominator

Step 3 :Fix the number of decimal places basing on the calculated value.

y(m)	$\frac{1}{\text{y}}(m^{-1})$
0.300	3.33
0.400	2.50
0.500	2.00
0.600	1.67
0.800	1.25
0.900	**1.11**

*The largest value in the column of the denominator is 0.900(3 S.F)*i.e Reciprocal=$\frac{1}{\text{largest value in y}}$

Squaring the same quantity

when squaring the same quantity e.g x^2, y^2, v^2, e.t.c there is no need for testing.The following steps are followed

- **Step 1**:Identify the largest value in the column you are squaring
- **Step 2**:obtain the calculated value basing on the number of S.F of that variable
- **Step 3**:Fix the decimal places for the rest of the values

x(m)	x^2(m^2)
0.050	20.000
0.100	10.000
0.120	8.333
0.250	4.000
0.300	3.333
0.500	**0.250**

The largest value in the column is 0.500m(3S.F) thus our answer must be to 3 S.F

WORKED EXAMPLES

Table 1.1

for n=20 0scillations

x(m)	$\frac{1}{x}$(m^{-1})	t(s)	t^2(s^2)	T(s)	T^2(s^2)
0.900	1.11	**17.76**	315.4	**0.8880**	0.7885
0.800	1.25	15.25	232.6	0.7625	0.5814
0.700	1.43	12.94	167.4	0.6470	0.4186
0.600	1.67	10.62	112.8	0.5310	0.2820
0.500	2.00	8.40	70.6	0.4200	0.1764
0.400	2.50	6.50	42.3	0.3250	0.1056

Column of $\frac{1}{x}$

In the column of $\frac{1}{x}$,the calculated value is obtained by using the largest value in the column of x.The largest value is 0.900(3 S.F), $\frac{1(F.V)}{0.900(3S.F)} = 1.11(3S.F)$.Thus all values must be recorded to 2d.p

Column of t^2

In the column of t^2 ,the calculated value is obtained by squaring the largest number in the column of t.The largest number is 17.76(4S.F),$t^2 = (17.76)^2 = 315.4$(4S.F).Thus all values in the column must be written to 1d.p

Column of T

In the column of T ,the calculated value is obtained by considering the largest quotient .
$T = \frac{17.76(4S.F)}{20(F.V)} = 0.8880(4S.F)$*.Thus all values in the column must be written to 4d.p*

Column of T^2

In the column of T^2 ,the calculated value is obtained by considering the largest product .
$T = (0.8880)^2(4S.F) = 0.7885(4S.F)$*.Thus all values in the column must be written to 4d.p*

Table 1.2

$\alpha(^0)$	$\sin\alpha$	$\sin^2\alpha$	$\beta(^0)$	$\sin\beta$	$\frac{1}{\sin\beta}$
20	0.342	0.117	14	0.242	4.13
30	0.500	0.250	17	0.292	3.42
40	0.643	0.413	23	0.391	2.56
50	0.766	0.587	28	0.469	2.13
60	0.866	0.750	32	0.530	1.87
70	0.940	0.884	36	0.588	1.70
80	0.985	0.970	40	0.643	1.56

Column of $\sin\alpha$ and $\sin\beta$

In the columns of $\sin\alpha$ and $\sin\beta$,the trigonometric functions are written to 3d.p.Thus all values in the column must be written to 3d.p

Column of $\sin^2\alpha$

In the column of $\sin^2\alpha$,the largest value in the column of $\sin\alpha$ is 0.985(3S.F),thus applying the rule for multiplication $(0.985)^2$=0.970(3S.F) .Thus all values in the column must be written to 3d.p

Column of $\frac{1}{\sin\beta}$

In the column of $\frac{1}{\sin\beta}$,the largest value in the column of $\sin\beta$ is 0.643(3S.F), $\frac{1(F.V)}{0.643(3S.F)}$ =1.56(3S.F).Thus all values in the column must be written to 3d.p

Table 1.3

I(A)	$\frac{1}{\mathrm{I}}$(A^{-1})	V(V)	$\frac{\mathrm{V}}{\mathrm{I}}$($\Omega$)	$\sqrt{\mathrm{V}}$(V)
0.65	1.5	1.65	2.5	1.28
0.56	1.8	1.90	3.4	1.38
0.44	2.3	2.05	4.7	1.43
0.35	2.9	2.10	6.0	1.45
0.26	3.8	2.25	8.7	1.50

Column of $\frac{1}{I}$

In the column of $\frac{1}{I}$,the largest value in the column of I is 0.65(2S.F),$\frac{1(F.V)}{0.65(2S.F)}$ =1.5(2S.F).Thus all values in the column must be written to 2d.p

Column of $\frac{V}{I}$

In the column of $\frac{V}{I}$,the largest quotient is $\frac{2.25(3S.F)}{0.26(2S.F)}$=8.7(2S.F).Thus all values in the column must be written to 1d.p

Table 1.4

x(cm)	x^2(cm)	$\frac{1}{x^2}$(cm^{-2})	$\sqrt{x^2}$(cm)
6.0	36	0.027	6.000
6.2	38	0.026	6.164
6.4	41	0.024	6.403
6.6	44	0.023	6.633
7.0	49	0.020	7.000
7.4	55	0.018	7.416

Column of x^2

For the column of x^2 ,the largest value in the column of x is 7.4(2S.F),thus applying the rule for multiplication $(7.4)^2$=55(2S.F) .Thus all values in the column must be written to 2d.p

Column $\sqrt{x^2}$

For the column of $\sqrt{x^2}$,the largest root is $\sqrt{55}$ =7.416(Roots of whole numbers are written to 3d.ps)

Table 1.5

y(m)	$\frac{1}{\mathrm{y}}$(m^{-1})	V(V)	$\frac{1}{\mathrm{V}}$(V^{-1})	I(A)	I^2(A^2)
0.200	5.00	0.50	2.000	0.40	0.16
0.300	3.33	0.60	1.667	0.36	0.13
0.400	2.50	0.70	1.429	0.32	0.10
0.500	2.00	0.90	1.111	0.28	0.08
0.600	1.67	1.00	1.000	0.24	0.06
0.700	1.43	1.10	0.909	0.20	0.04

Column of $\frac{1}{\mathbf{y}}$

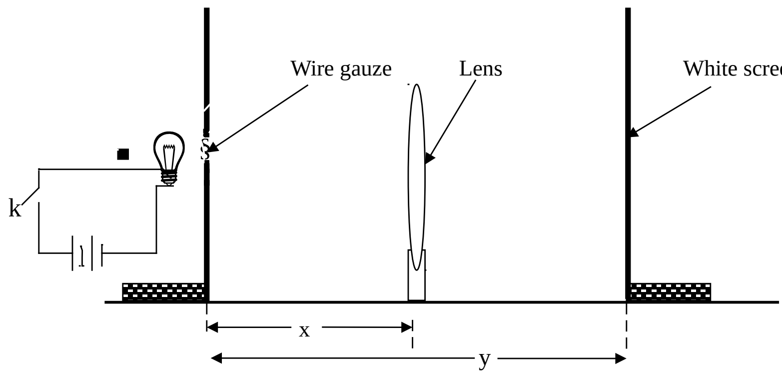
For the column of y,the largest value in the column is 0.700(3S.F),thus applying the rule $\frac{1}{0.700(3S.F)}$ = $1.43(3S.F)$ *.Thus all values in the column must be written to 2d.p*

1.2.14 Worked out Experiments

In this experiment ,you will determine the constant, α ,of the converging lens provided
Apparatus: 1 convex lens(f=10.0cm),1 lens holder,1 metre rule,1 torch bulb,2 fresh dry cells,1 switch labelled k,1 white screen with a wire gauze.

(a) Connect a pair of dry cells, atorch bulb and a switch K in series

(b) Arrange the bulb,screen with a wire gauze,lens and the white screen as shown below



(c) Adjust the position of the lens so that the distance.x ,between the wire gauze and the lens is 20.0cm

(d) close switch k

(e) Adjust the position of the white screen until a clear image of the wire gauze is obtained on it

(f) Measure and record the distance ,y, between the wire gauze and the white screen

(g) Open switch,k

(h) Repeat procedures (c) to (g) for values of x=25.0,30.0,35.0,40.0 and 45.0cm

(i) Record your results in a suitable table including values of x^2,$\frac{x^2}{y}$ and $\frac{1}{x}$

(j) Plot a graph of x against $\frac{x^2}{y}$

(k) Determine the slope ,S of the graph

(l) Find the intercept ,C on the x-axis

(m) Calculate α using the expression $\alpha = CS$

RESULTS

x(cm)	$\frac{1}{x}$(cm^{-1})	x^2(cm^2)	y(cm)	$\frac{x^2}{y}$ (cm)
20.0	0.0500	400	40.0	10.0
25.0	0.0400	625	41.7	15.0
30.0	0.0333	900	45.0	20.0
35.0	0.0286	1230	49.0	25.1
40.0	0.0250	1600	53.3	30.0
45.0	0.0222	2030	57.9	35.1

The multiplication and division rules are applied in the calculations

Obtaining the scale

Vertical scale

largest value=45.0

smallest value=20.0

$$VSI = \frac{L - S}{10} = \frac{45.0 - 20.0}{10} = 2.5$$

Vertical scale =5

i.e 2cm:5

Horizontal scale

largest value=35.1

smallest value=10.0

$$HSI = \frac{L - S}{8} = \frac{35.1 - 10.0}{8} = 3.1375$$

Horizontal scale =5

i.e 2cm:5

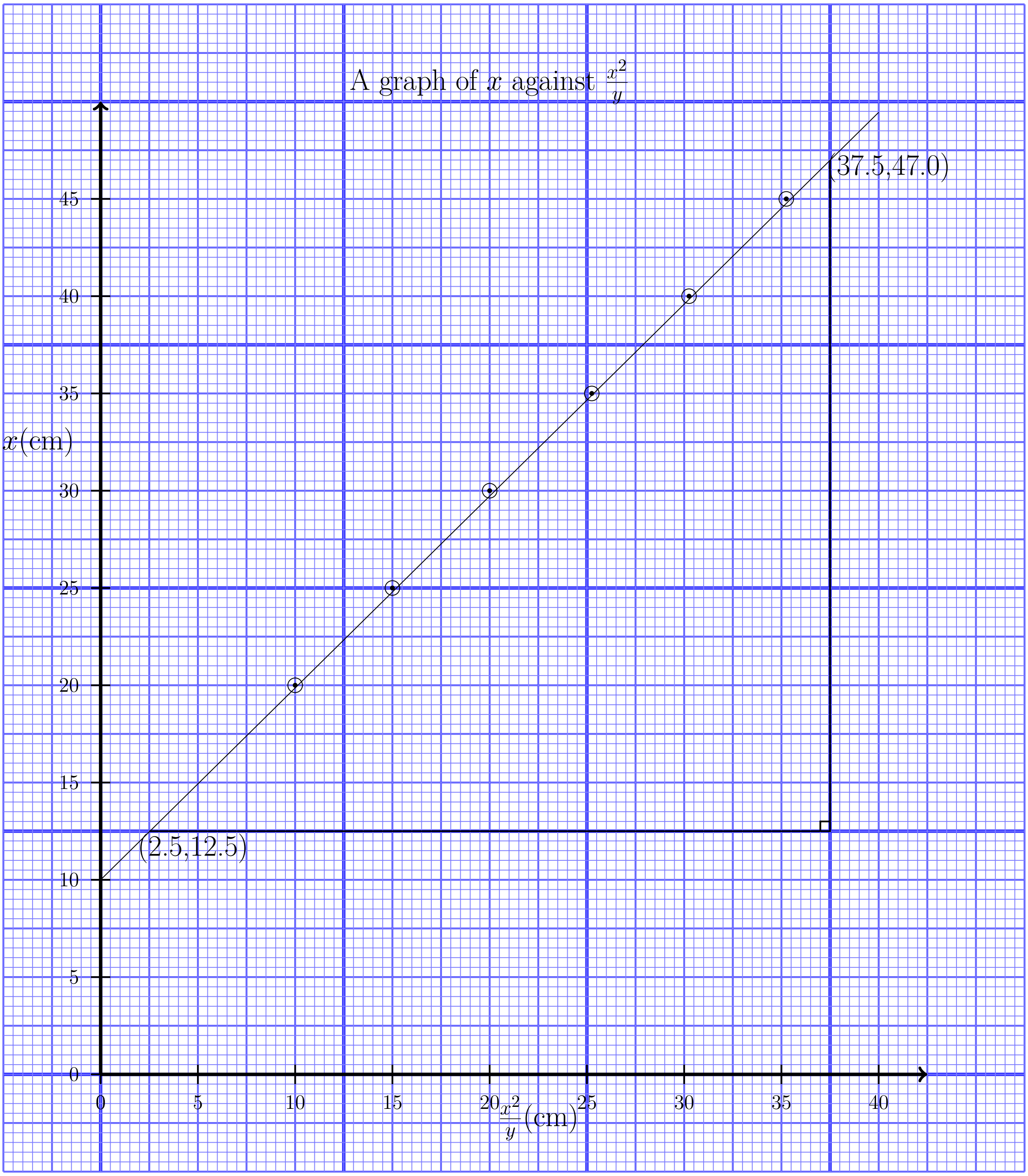
Values for the Slope (37.5,47.0),(2.5,12.5)

The values of the slope must be read correctly to the decimal places of the 1 division.i.e,for the vertical $1div = 0.5$(1d.p),therefore all values read from this axis must be written to 1d.p

$$s = \frac{47.0 - 12.5}{37.5 - 2.5} = \frac{34.5(3SF)}{35.0(3SF)} = 0.986$$

C=10.0cm

$$\alpha = CS = 10.0 \times 0.986 = 9.86cm$$

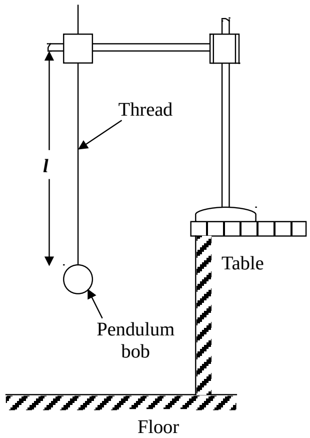


A graph of x against $\frac{x^2}{y}$
x(cm)
$\frac{x^2}{y}$(cm)
(37.5,47.0)
(2.5,12.5)
0
5
10
15
20
25
30
35
40
45

In this experiment ,you will determine the acceleration due to gravity ,g using a pendulum bob. .

Apparatus: 1 pendulum bob(50g),1 retort stand,1 metre rule,1 stopclock/watch,knitting thread.

(a) Suspend the pendulum bob using a string on retort stand as shown below



(b) Adjust the length of the pendulum bob ,l, so that it is equal to 0.100m

(c) Displace the bob throgh a small angle about the vertical and release it to oscillate in a vertical plane

(d) Determine the time for 20 oscillations

(e) Find the time ,T for one oscillation

(f) Repeat procedures (b) to (e) for values of l=0.200,0.300,0.400,0.500 and 0.600m

(g) Record your results in a suitable table including values of T^2

(h) Plot a graph of T^2(a long the vertical axis) against ,l(a long the horizontal axis)

(i) Determine the slope ,S of the graph

(j) Calculate g using the expression $gS = 4\pi^2$.where $\pi = 3.14$

Results

l(m)	t(s)	T(s)	$T^2(s^2)$
0.100	12.57	0.629	0.396
0.200	17.77	0.889	0.790
0.300	21.76	1.088	1.184
0.400	25.13	1.257	1.580
0.500	28.10	1.405	1.974
0.600	30.78	1.539	2.369

In the column of T

$$\begin{aligned} T =& \frac{t}{n} \\ =& \frac{30.78(4sf)}{20} \\ =& 1.539(4sf)[\text{largest quotient}] \end{aligned}$$

For the column of T^2,the largest product is obtained by squaring the largest number in the column of T.i.e T=1.539(4sf).

Obtaining the scale

vertical scale

largest value=2.369

smallest value=0.396

$$\begin{aligned} VSI =& \frac{L-S}{10} \\ =& \frac{2.369-0.396}{10} \\ =& 0.1973 \end{aligned}$$

Vertical scale =2.5

i.e 2cm:2.5

Horizontal scale

largest value=0.600

smallest value=0.100

$$\begin{aligned} HSI =& \frac{L-S}{8} \\ =& \frac{0.600-0.100}{8} \\ =& 0.0625 \end{aligned}$$

Horizontal scale =0.1

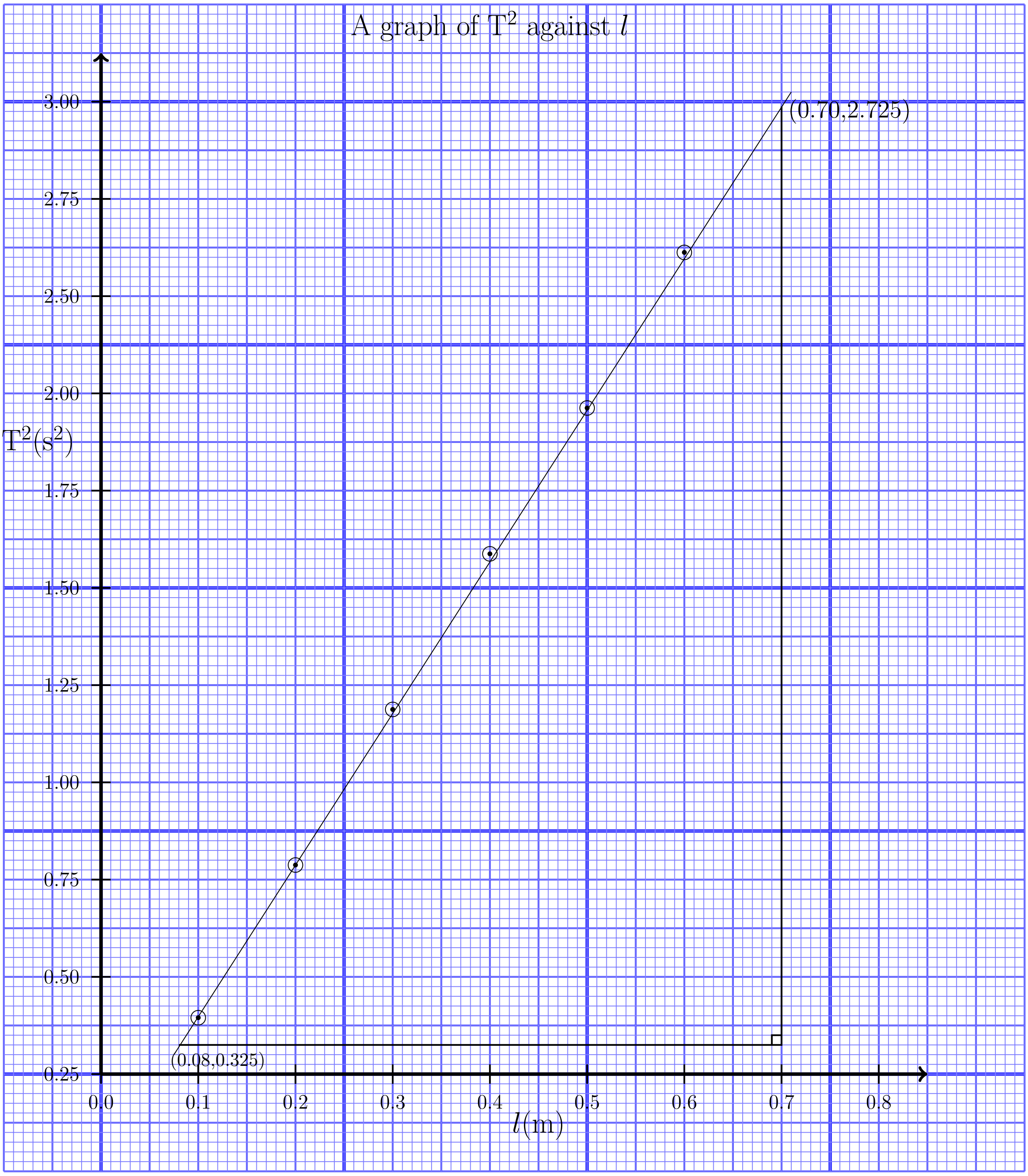
i.e 2cm:0.1

Values of the Slope (0.70,2.725),(0.08,0.325)

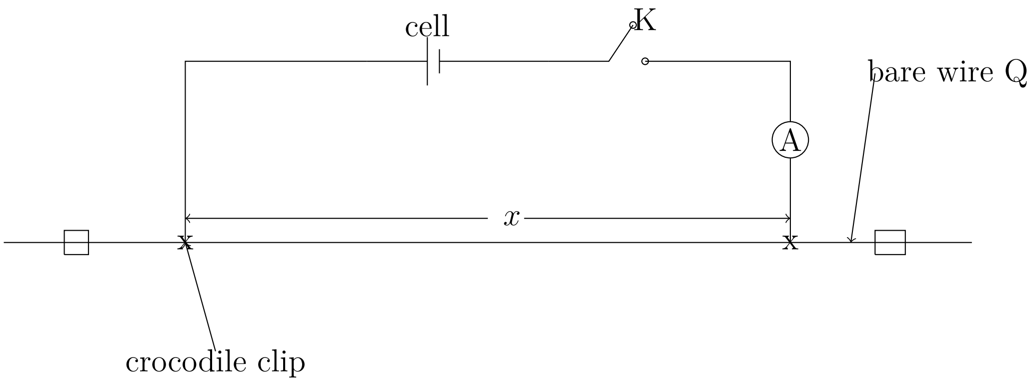
$$\begin{aligned} s =& \frac{2.725-0.325}{0.70-0.08} \\ =& \frac{2.400(4SF)}{0.62(2SF)} \\ =& 3.9m^{-1}s^2 \end{aligned}$$

$$\begin{aligned} gS =& 4\pi^2 \\ g =& \frac{4\pi^2}{S} \\ =& \frac{4\times(3.14)^2}{3.9} \\ =& 10ms^{-2} \end{aligned}$$

When dealing with the calculated value it weighs more compared to the float value.Therefore the significant figures of the calculated value 3.9(2S.F)are considered.


A graph of T^2 against l
$T^2(s^2)$
3.00
2.75
2.50
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
(0.70,2.725)
(0.08,0.325)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
l(m)

In this experiment ,you will determine the constant, r ,of the wire labelled Q.
Apparatus: 1 dry cell in a holder(1.5V),switch labelled k,1 ammeter(0-1A),4 connecting wires,2 crocodile clips„constantan SWG28 labelled Q



(a) Connect the circuit as shown above

(b) Staring with length x=0.600m,close switch K

(c) Record the ammeter reading I

(d) Determine the time for 20 oscillations

(e) Find the time ,T for one oscillation

(f) Repeat procedures (b) to (c) for values of x=0.500,0.400,0.300,0.200 and 0.100m

(g) Record your results in a suitable table including values of x^2,$\frac{1}{I}$

(h) Plot a graph of x(a long the vertical axis) against ,$\frac{1}{I}$(a long the horizontal axis)

(i) Determine the slope ,S of the graph

(j) Calculate r using the expression $2r = \sqrt{4.16 \times 10^{-7} S}$

Results

x(m)	x^2 (m^2)	I(A)	$\frac{1}{\mathrm{I}}$(A^{-1})
0.600	0.360	0.24	4.2
0.500	0.250	0.26	3.8
0.400	0.160	0.32	3.1
0.300	0.090	0.38	2.6
0.200	0.040	0.48	2.1
0.100	0.010	0.64	1.6

Obtaining the scale

Vertical scale

largest value=0.600

smallest value=0.100

$$VSI = \frac{L-S}{10}$$
$$= \frac{0.600-0.100}{10}$$
$$= 0.05$$

Vertical scale =0.1

i.e 2cm:0.1

Horizontal scale

largest value=4.2

smallest value=1.6

$$HSI = \frac{L-S}{8}$$
$$= \frac{4.2-1.6}{8}$$
$$= 0.325$$

Horizontal scale =0.5

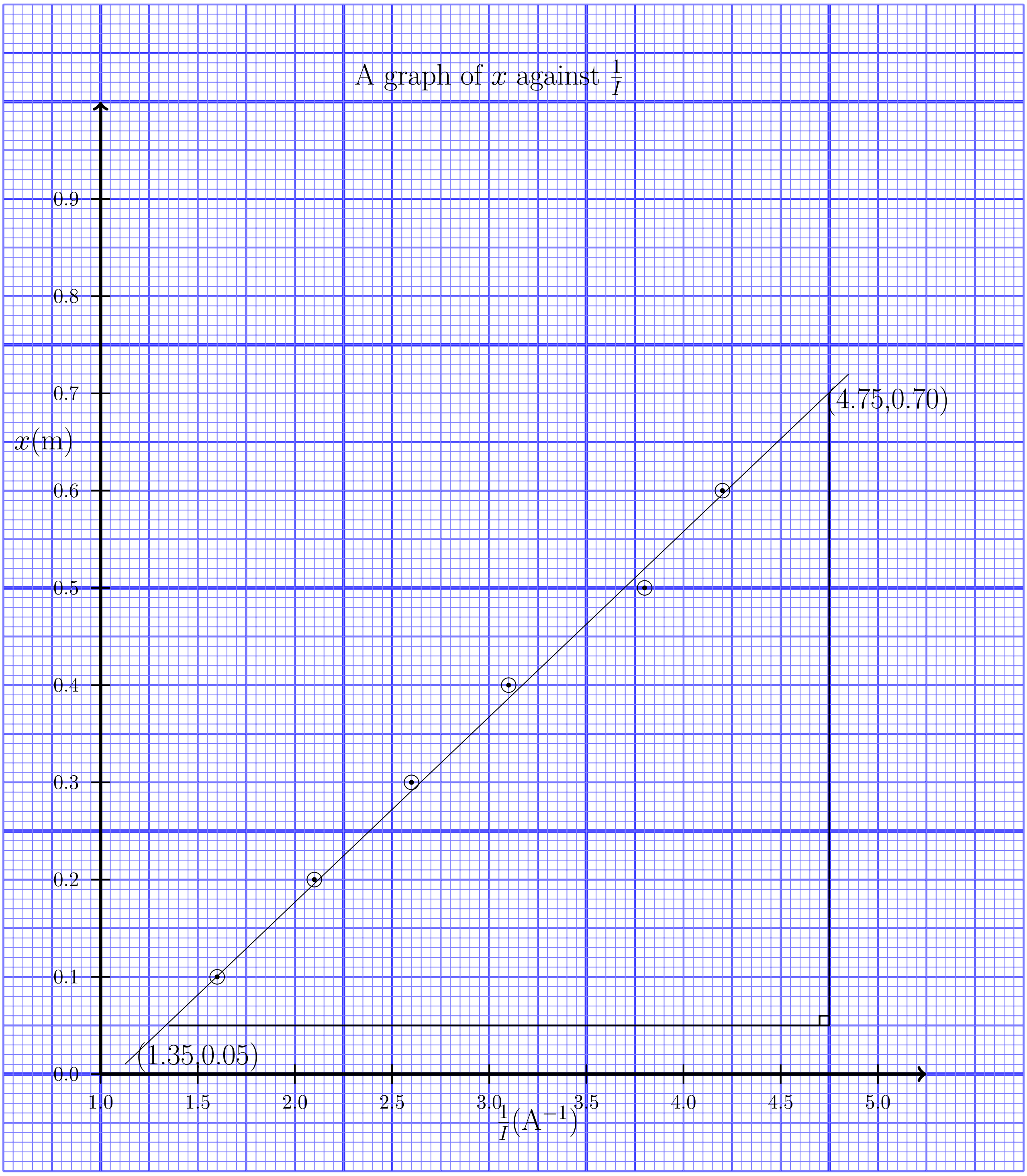
i.e 2cm:0.5

Values of the Slope (1.35,0.05),(4.75,0.70)

$$s = \frac{0.70-0.05}{4.75-1.35}$$
$$= \frac{0.65(2SF)}{3.40(3SF)}$$
$$= 0.19mA$$

During dividing the rules are applied and the answer written to the least number of significant figures.Units must be included on the final answer

$$2r = \sqrt{4.16 \times 10^{-7} S}$$
$$r = \frac{1}{2}\sqrt{4.16 \times 10^{-7} \times 0.19}$$
$$r = 1.4 \times 10^{-4} m$$


A graph of x against $\frac{1}{I}$
x(m)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
$\frac{1}{I}(\mathrm{A}^{-1})$
(4.75,0.70)
(1.35,0.05)

Exercise on the data presentation and graph work

u(cm)	v(cm)
20.0	20.0
25.0	16.7
30.0	15.0
35.0	14.0
40.0	13.3
45.0	12.8
50.0	12.5
55.0	12.2
60.0	12.0

1(a) Include values of (u+v) ,uv, $\frac{\mathrm{u}}{\mathrm{v}}$ and (1+ $\frac{\mathrm{u}}{\mathrm{v}}$)

(b) Plot a graph of (u+v) against (uv)

(c) Plot a graph of u against (1+ $\frac{\mathrm{u}}{\mathrm{v}}$)

(d) Determine the slope f of the graph

i (^{0})	r (^{0})
10	6
20	13
30	19
40	25
50	31
60	35
70	39
80	41

2(a) Include values of $\sin i, \sin r, \cos i, \cos r$,and $\frac{1}{\sin i}$

(b) Plot a graph of $\sin i$ against $\sin r$

(c) Determine the slope **s** of the graph

l (m)	t(s)
0.900	17.76
0.800	15.25
0.700	12.94
0.600	10.62
0.500	8.40
0.400	6.50

3(a) Include values of t^2, T, T^2, ,and $\frac{1}{T^2}$ assuming 20 0scillations

(b) Plot a graph of l against T^2

(c) Determine the slope **s** of the graph

i (^{0})	r (^{0})	x(cm)
10	6	0.8
20	14	1.6
30	20	2.4
40	28	3.5
50	30	4.0
60	35	4.8

4(a) Include values of $\sin^2 i, \sin^2 r, \cos^2 i, \frac{1}{x}, x\cos r$,and $\frac{1}{\sin^2 i}$

(b) Plot a graph of $\sin i$ against $\sin r$

(c) Determine the slope **s** of the graph

y(m)	t(s)
0.900	38.0
0.800	36.0
0.700	33.5
0.600	31.0
0.500	28.5
0.400	25.5
0.300	23.5
0.200	21.0

5(a) Include values of $t^2, T, T^2, ,$ and $\frac{1}{T^2}$ assuming 20 oscillations as your time

(b) Plot a graph of T^2 against y

(c) Determine the slope **S** of the graph

(d) Calculate the constant k from the expression $S = \frac{4\pi^2}{k}$

I(A)	V(V)
0.26	2.25
0.35	2.10
0.44	2.05
0.56	1.90
0.65	1.65
0.74	1.40
0.83	1.20
0.92	0.95

6(a) Include values of $\frac{1}{I}, \frac{1}{I^2}, \frac{1}{V}, \frac{1}{V^2}$, and, IV

(b) Plot a graph of $\frac{1}{I}$ against $\frac{I}{V}$

(c) Determine the slope **S** of the graph and the intercept on the vertical axis

i (^{0})	r (^{0})	y(m)
10	6	0.350
20	13	0.230
30	19	0.175
40	25	0.135
50	31	0.110
60	35	0.100
70	39	0.088
80	41	0.083

7(a) Include values of $\frac{1}{y}, \sin i, \sin r, \text{and}, y \sin i$

(b) Plot a graph of y against $\sin r$

(c) Determine the slope **S** of the graph and the intercept on the vertical axis

$x(m)$	y(m)
0.090	0.750
0.220	1.500
0.310	2.000
0.420	2.700
0.480	3.050
0.550	3.500
0.680	4.250
0.730	4.600

8(a) Include values of $\frac{1}{y}, \frac{1}{x}, \frac{1}{xy}, \text{and}, \frac{x}{y}$

(b) Plot a graph of y against x

(c) Determine the slope **S** of the graph and the intercept on the vertical axis

u(cm)	v(cm)
1.5f	29.0
2.0f	19.6
2.5f	17.2
3.0f	16.0
3.5f	15.0
4.0f	13.0
4.5f	12.5

Given that f=10.0 cm.

9(a) Include values of $u, u + v, \frac{1}{u}, \text{and}, \frac{1}{u+v}$

(b) Plot a graph of $u + v$ against u

(c) Determine the slope **S** of the graph and the intercept on the horizontal axis

x(cm)	y(cm)
20.0	40.0
25.0	41.7
30.0	45.0
35.0	49.0
40.0	53.3
45.0	57.8

10(a) Include values of $x^2, \frac{x^2}{y}, \frac{1}{x^2}$

(b) Plot a graph of x against $\frac{x^2}{y}$

(c) Determine the slope **S** of the graph and the intercept C on the $x-$ axis

(d) Clculate α,using the expression $\alpha = CS$

$x(m)$	t(s)
0.900	19.04
0.800	21.49
0.700	24.11
0.600	27.96
0.500	33.63
0.400	42.24

11(a) Include values of T^2, $\frac{1}{x^2}$ for n=20 oscillations

(b) Plot a graph of xT^2 against $\frac{1}{x^2}$

(c) Determine the slope **S** of the graph

(d) Calculate I,using the expression $I = \frac{SMg}{4\pi^2 l}$ where $\pi = 3.14$,g=9.81,M=120.50g,l=50.0cm

$x(m)$	t(s)
0.100	14.5
0.150	15.0
0.200	16.0
0.250	17.0
0.300	18.5
0.350	20.0

12(a) Include values of T, T^2, x^2 for n=20 oscillations

(b) Plot a graph of xT^2 against x^2

(c) Determine the slope **S** of the graph

(d) Determine the intercept C on the T^2-axis

$y(m)$	t(s)
0.900	19.0
0.800	21.0
0.700	23.0
0.600	27.0
0.500	32.5
0.400	39.5

13(a) Include values of T^2, $\frac{\mathrm{x}}{y}$ for n=20 oscillations and x=0.950m

(b) Plot a graph of xT^2 against $\frac{1}{y^2}$

(c) Determine the slope **S** of the graph

$x(m)$	R(Ω)
0.323	1
0.642	2
0.965	3
1.268	4
1.604	5
1.907	6

14(a) Include values of $\frac{1}{x}$

(b) Plot a graph of x against R

(c) Determine the slope **S** of the graph

(d) Calculate R_s,using the expression $R_s = \frac{1}{S}$

$d(cm)$	P_1 (cm)	P_2 (cm)
41.0	15.3	24.6
46.0	13.5	31.8
51.0	12.5	37.5
56.0	11.8	42.7
61.0	11.5	48.1
66.0	11.0	53.4

15(a) Include values of $e = P_2 - P_1, e^2, d^2 - e^2$

(b) Plot a graph of $d^2 - e^2$ against d

(c) Determine the slope **S** of the graph

(d) Calculate f,using the expression $f = \frac{S}{4}$

$d(cm)$	P_1 (cm)	P_2 (cm)
41.0	15.3	24.6
46.0	13.5	31.8
51.0	12.5	37.5
56.0	11.8	42.7
61.0	11.5	48.1
66.0	11.0	53.4

16(a) Include values of $\sin i, \sin r, \sin^2 i, l^2, \frac{1}{l^2}$

(b) Plot a graph of $\frac{1}{l^2}$ against $\sin^2 i$

(c) Find the slope **W** of the graph

(d) Read and record the intercept C on $\frac{1}{l^2}$ -axis

(e) Find n from $n = (\frac{C}{-W})^2$

$l(m)$	V (V)	I (A)
0.200	1.05	0.82
0.300	1.15	0.50
0.400	1.25	0.40
0.500	1.30	0.38
0.600	1.35	0.30
0.700	1.45	0.20

17(a) Include values of $\frac{V}{I}, IV, \frac{1}{l}$

(b) Plot a graph of $\frac{V}{I}$ against l

(c) Find the slope **S** of the graph

$M(kg)$	P_1 (cm)
0.100	9.4
0.200	11.4
0.300	13.5
0.400	14.7
0.500	15.9
0.600	17.2

18(a) Include values of $e = P_1 - P_0, M + M_0$ for M_0=80.3g,P_0=8.4cm

(b) Plot a graph of e against $M + M_0$

(c) Find the slope **W** of the graph

Chapter 2

ELECTRICITY PRACTICALS

2.1 Introduction

For over years electricity has been one of the cheapest numbers to do.Many candidates have discovered that electricity is the easiest number to score since it contains few columns.Therefore for one to score highly you need to have constant practice such that you are familiar with the apparatus.This chapter has been enriched with numerous practicals and different areas have been tested.

2.1.1 Tips on passing Electricity experiments

- Arrange the apparatus provided as in the figure displayed in the question
- Check the ammeter and voltmeter to find out whether the pointer is at zero mark of the scale before using it
- Readings of ammeter and voltmeter MUST be taken when the pointer is steady.
- The Voltmeter must be connected in parallel a cross a device whose p.d is required.i.e Positive terminal is connected to the positive source of the e.m.f and negative terminal to the negative of the source
- The ammeter must be connected in series with the resistor through which the currrent is to be measured
- The instructions must be followed .i.e when told to open or close the switch
- When the pointer deflects in anticlockwise direction(backward) beyond the zero mark,just change your terminals.

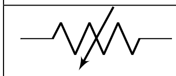
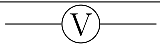
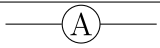
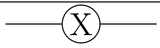
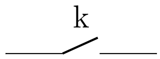
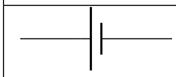
2.1.2 Derived quantities used in electricity and their units

Quantities	Name	Units
V	volt	V
I	ampere	A
$\frac{1}{I}$	per ampere	(A^{-1})
$\frac{1}{V}$	per volt	(V^{-1})
$\frac{1}{R}$	per ohm	(Ω^{-1})
$\frac{V}{I}$	ohm	(Ω)
$\frac{I}{V}$	per ohm	(Ω^{-1})
$\frac{V^2}{R}$	watt	(W)
I^2R	watt	(W)
IV	watt	(W)

2.1.3 Reading a voltmeter and an ammeter.

Ammeters and voltmeters are read to an accuracy of the smallest division(least count).When reading a voltmeter or an ammeter, obtain the number of marks indicated by the pointer from the zero mark and multiply it by what each mark represents(least count of the instrument).An ammeter or voltmeter of two scales usually has three terminals; the red terminal denotes positive (+) and the black denotes negative (-).

2.1.4 Common Symbols for electrical diagrams

Symbol	Name
	Variable resistor
	Voltmeter
	Ammeter
	Bulb
	Switch
	Battery

2.2 COMMON MISTAKES MADE BY CANDIDATES IN PHYSICS PRACTICALS WHICH LEAD TO LOSS OF MARKS

- Inability to comprehend and follow instructions as directed in the procedures
- Wrong recording of units and symbols.e.g In 2019 many candidates failed electricity experiments because of use of different symbols from the ones given in the question to represent certain quantities.i.e writing X instead of x ,Y instead of y,$\frac{1}{V}$ instead of $\frac{I}{V}$
- Failure to interpret units of reciprocals of quantities e.g $\frac{V}{I}$, $\frac{1}{V}$
- Wrong rounding off of values
- Poor handwriting more so in the table of results.i.e During construction of numerals
- Wrong significant figures during calculation
- Inconsistency of the decimal places for the tabulated values
- Use of wrong scale .Many students fail too use the right scale more so when it comes to graphs that involve intercepts
- Failure to hand in the tracing paper for light experiments.e.g for the glass block
- Poor plotting of points and failure to identify the line of best fit that suits the plotted points
- Failure to use the measuring instruments and recording the quantities depending on the least count of the instrument at hand
- Wrong substitution of values for a given expression
- poor planning and chronological scrutiny of procedures.candidates waste alot of time on particular numbers and end up not finishing the required load
- Failure to derive units from calculation of slope and intecepts obtained
- Including units in the title of the graph and inappropriate underlining
- Violation of the decimal places to which a particular measuring instrument must be recorded

- Failure to convert units when required in a particular form.e.g from g to kg,cm to m
- Poor time management in line with the exam time frame.
- In ability to set up the experimental diagrams as displayed in the question
- Wrongly Writing fullstops after units .its very wrong therefore students must avoid it e.g m.(not accepted)
- Writing units for trigonometric functions.Students are informed that sin,cos,and tan have no units
- **Use of a pencil when presenting their experimental observations.i.e during graphing,tabulation ,calculation which is absolutely wrong.**CANDIDATES MUST USE ONLY A PEN WHEN RECORDING THEIR EXPERIMENTAL OBSERVATIONS

For any correction,help and advice ,reach me on the following addresses
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