For inquires, contact
0757298014
mwijukacrescent4@gmail.com

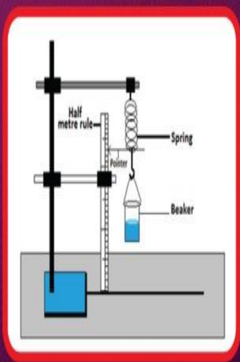
PHYSICS PACTICAL WORK BOOK FOR NEW LOWER SECONDARY CURRICULUM S3 AND S4 2025 EDITION

PHYSICS PRACTICAL

WORK BOOK

FOR NEW LOWER SECONDARY CURRICULUM

2025 EDITION



S3 AND S4

PHYSICS PRACTICAL WORK BOOK FOR NEW LOWER SECONDARY CURRICULUM

S3 AND S4

2025 EDITION

In case of any technical reaction inform of suggestion, criticism etc.

Contact: +256757298014/mwijukacrescent4@gmail.com

STUDENT'S PARTICULARS

Student's name

Class

Stream

Year

Facilitator's name

PREFACE

This book is intended to help leaners who are preparing to sit for their final ordinary level examination particularly in physics practical under new lower secondary level curriculum.

The book is written basing on the content of physics in new lower secondary level curriculum as guided by NCDC physics syllabus and UNEB

The book contains worked examples, test items from mechanics, light and electricity. All the content is condensed to enable self-study.

The book contains theory, possible diagrams of most common experiments in ordinary level physics. The example of updated physics practical score grid (marking guide 2024) format is also provided in this book.

There is no doubt that this book will be helpful to all suitable users across the country.

ACKNOWLEDGMENT

I am thankful to the almighty God for giving me the gifts of life, knowledge and wisdom that have enabled me to come up with this book.

Thanks to the physics departmental members of the following schools whom I served with at some point. St Joseph’s Girls senior secondary school Nsambya, St Noa girls secondary school Zana, Maryland high school-Entebbe (Kigungu main campus), King’s way high school - kitende, Kairos high school Muyenga, Central college high school - Bulenga campus and Ebenezer Christian high school -Bulenga. You added a brick in my career development.

Thanks to all senior physics facilitators across the country especially those who have **reviewed and edited this book**. May God bless you

DEDICATION

This book is dedicated to all physics facilitators across the country

This book is also dedicated to all our dear learners of physics across the country. You are the main reason as to why we wrote this book.

TABLE OF CONTENTS

Contents

INTRODUCTION

Ordinary level physics practical (535/2 and 353/3) has been revised under new lower secondary curriculum as follows

Structure

The paper consists of ***two scenario-based*** items set from either mechanics and light or, light and electricity or mechanics and electricity. A candidate will be required to answer only ***one*** item.

Duration.

The time allocated to this paper is strictly two hours. Candidates are advised to use the first 15 minutes for planning which may include,

i. Reading and understanding the scenario items asked. (Each scenario should be read at least twice). Make sure you fully understand the items before making a choice on the item you are to answer)
ii. Checking and making the choice of the apparatus you are going to use in your set up and procedures.
iii. Understanding the aim, hypothesis and variables involved in the experiment to be under taken
iv. Understanding on how data will be presented.
   For example, which quantities are to be included in the table of results, how will data be analysed (do you need a graph, then slopes, then intercepts etc.?).
v. Drawing conclusion from data analysed to prove your hypothesis and give appropriate advice.

PRESENTATION OF PHYSICS PRACTICAL WORK (PRACTICAL REPORT) BASED ON A SCIENTIFIC INVESTIGATION.

Aim of the experiment.

This is a general statement that guides your steps throughout the experiment. It brings out the main objective as to why you are carrying out the experiment. It is derived from the scenario item at hand. At the end of the experiment, make sure that you have achieved the aim of the experiment. For example, if the aim of your experiment was

‘’A scientific investigation to determine the mass of the metre rule”. At the end of the experiment, you should come up with the mass of given metre rule.

Variables.

These are quantities whose values may vary during the experiment. These variables are divided into three. That is;

Hypothesis.

This is a general statement that predicts the outcome of the experiment. At the end of the experiment, it can be proven correct or wrong. It is derived from the situational (scenario) item set.

For example,

When John, a camera man took his lens camera for repair, the technician (mechanic) advised him that the lens to be used in repairing the lens camera should be of focal length f, ranging from 10cm to 15cm.

Your hypothesis basing on this scenario may be

“The focal length f of the lens to be used in repairing the lens camera is in the range from 10cm to 15cm, or $10 \leq f \leq 15cm$”.

If at the end of the experiment, your focal length is let's say 13.5cm, then your hypothesis is proved correct (tested positive) and the lens can be used to repair the lens camera of the camera man.

However, if the value of f is 9.0cm or 20.0cm, then your hypothesis is tested negative since the obtained value of f does not lie in the expected range of

$10 \leq f \leq 15cm$ and therefore the lens cannot be used to repair the lens camera of the camera man

List of apparatus.

Experimental set up.

Under this, you can sketch a simple diagram that is well labelled to show how your apparatus are to be arranged. The diagram guides the logical flow of your procedures.

Procedure or steps

Under this, write the steps taken to come up with results. The procedures must be...

You should properly number your steps

Sources of errors and mitigation (precautions).

Some times after running the experiment and analysing data, the outcome may not be exactly the same as to what was expected!

In most cases this could be a result of the errors that arise as we do the experiment. Sources of such errors depends

Once those errors are specified, go ahead and suggest how they can be minimised or avoided.

Data presentation

Record the single measurements first if necessary for example, the initial position of the pointer $P_O = 45.6cm$, The balancing point $G = 49.5cm$

After this, design a suitable table where results are to be tabulated. In the table of results,

Data analysis.

Data recorded in your table has to be analysed so as to accomplish the aim the experiment and test the hypothesis. Data is analysed by plotting relevant graph(s) or

Conclusion and advice

value of the slope or value obtained after substituting the slope in the appropriate formula or the **trend of the graph** to prove your hypothesis, make conclusions in relation to your aim and give appropriate advice

For example,

then by substitution in $\boldsymbol{f = \frac{1}{s}}$

$$\boldsymbol{f = \frac{1}{0.5\ cm^{-1}} = 10\ cm}$$

conclusion and advice should be stated as follows;

The value of focal length f of the lens is 10cm which lies in the range of

$8\text{cm} < \text{f} < 15\text{cm}$ hence the hypothesis is tested positive.

The lens can be used to repair the lens camera of the camera man

SUMMARY OF A PHYSICS SCIENTIFIC INVESTIGATION REPORT

- Aim of the investigation
- Variables
- Hypothesis
- List of apparatus
- Experimental set up (diagram
- ,
- .
- .
-
- Conclusion and advice

WRITING UNITS AND THEIR SYMBOLS

When writing symbols of measured quantities, the following points should be noted

i. All units of measured quantities should be same as those of their respective instruments unless told to write the values in other units. For example, when the length of a wire is measured using a metre rule, the value should be written in centimetres (cm) e.g., 5.0cm, when the

ii. All units of derived quantities are derived units and should be written in index form (where applicable). Forward slash (/) should be avoided when writing such units e.g., density $\boldsymbol{\rho = 1000kgm^{-3}}$ but not $\boldsymbol{\rho = 1000kg/m^3}$

iii. Units

LEAST COUNT OF A MEASURING INSTRUMENT

Least count is the smallest value that can be read from a scale of given measuring instrument. This is very important as it helps us to know the number of decimal places (degree of accuracy) a value read from that instrument should be recorded to.

$$\boldsymbol{least\ count} = \frac{\boldsymbol{main\ division}\ (\boldsymbol{the\ first\ value\ after\ zero\ on\ the\ given\ scale})}{\boldsymbol{number\ of\ small\ divisions\ within}}$$

Ideally, least count represents the value of each small division on a given scale of a measuring instrument. For example, on a metre rule;

least count = $\frac{1}{10} = 0.1cm\ (1dp)$.Hence all values read from the scale of a metre rule are to be recorded to 1dp in cm

Using that idea, the degree of accuracy of all measuring instruments can be obtained easily as follows

Instrument	Quantity it measures	Units	Symbol of unit	Degree of Accuracy or least count (Number of ddecimal points dp)
Metre rule	Length l ($l \geq 10$cm)	centimetres	cm	0.1cm (1dp)
Protractor	Angles	degrees	^{0}	0dp
Beam balance	Mass	grams	g	1dp

Graph paper	Length	centimetres	cm	1dp (since 5small squares represents 1cm, $1sq = \frac{1}{5} = 0.2cm\ (1dp)$

DECIMAL PLACES AND SIGNIFICANT FIGURES

DECIMAL PLACES (dp)

A decimal place is a specific position of a digit in the fractional part of a decimal number.

A decimal point is a dot that separates whole and fractional parts of a given number.

Number of decimal places ….

PROCESS OF ROUNDING OFF

Example

Rounding of the following to the required number of dp as indicated in brackets

a) $23.44676\ (0,1,2dp)$

Exercise.

1. Round off the following as instructed in brackets

a) $0.0067459897(0,1,2,3,4,5dp)$.

____

____

2. Rund off the following as instructed in brackets

b) $2457.4567(1,2,3,4,5,7,9dp)$

SIGNIFICANT FIGURES (sf)

Significant figure represents the precision (consistency or reproducibility) of a measurement or a calculation.

IDENTIFYING THE SIGNIFICANT FIGURES.

a) All non-zero digits are significant figures. These digits are 1,2,3,4,5,6,7,8,9
b) Zeros may or may not be significant as explained below

Take a look at the following example

- A number 249897 can be rounded off to 2sf so that it becomes 250000. The last four zeros are not counted as sf since they result from approximation (rounding off)
  For that matter, it is correct to take all trailing zeros in varying or measured value as significant figures.

ROUNDING OFF TO THE GIVEN NUMBER OF SIGNIFICANT FIGURES

Steps

Note: When counting the number of significant figures, we start from the first significant number irrespective of the position of decimal point.

Example

Round off the following to the required number of sf as indicated in brackets

a) 10.1469879 (3,5,6 ,2,1)
b) 45873 (1,2,3,6 sf)
c) 0.01048976 (1,2,4sf)

Exercise

MANIPULATION OF EXPERIMENTAL VALUES

When manipulating experimental values, two key concepts must guide you to improve on the accuracy of experimental and calculated values. These are concepts of decimal places and significant figures.

Manipulation of experimental data usually involve mathematical operations of addition, subtraction, multiplication and division

RULES OF DATA MANIPULATION

(TREATMENT OF EXPERIMENTAL VALUES)

Addition and subtraction

When adding or subtracting two measured or calculated values, maintain the number of decimal places of the least accurate value *(maintain the least number of dp).*

Least accurate value in this case is the value with least number of decimal places.

Examples

a) $4.508\ (3dp)\ +\ 0.2(1dp)\ =\ 4.7\ (1dp)$

Multiplication and division

when multiplying or dividing two or more measured or calculated values, maintain the number of significant figures

i. $4.508\ (4sf)\ \times\ 0.2(1sf)\ =\ 0.9\ (1sf)$

ii. $0.2345\ (4sf)\ \div\ 0.12\ (2sf)\ =\ 1.0\ (1sf)$

a) $If\ x\ =\ 0.075\ and\ y\ =\ 0.00483, then$

i. $xy\ =\ 0.075 \times 0.00483\ =\ 3.6 \times 10^{-5}\ or\ 0.00036\ (2sf)$

ii. $x\ \div\ y\ =\ 0.075\ \div\ 0.00483\ =\ 16(2sf)$

Exercise

$If\ x\ =\ 0.075\ , y\ =\ 0.00483\ and\ \ z\ =\ 1.23,$ find;

i. $\frac{(x+y)}{xz}$

ii. $\frac{(xy-z^2)}{xyz}$

iii. $\frac{y}{xz} - xz$

iv. $xyz - xy - z$

Note:

i. The logarithm of a measured value, the roots (square root, cube root etc.) of a non-measured whole number or a float (to be discussed later), the trigonometric ratios of measured angles (sin, cos and tan) are all recorded to three decimal places $e.g., sin\ 38^0\ =\ 0.616, \sqrt[3]{45}\ = 3.557,\ log2 =\ 0.301,$ $In2\ =\ 0.693\ \ etc.$

ii. For the root of non-float

………………………………………………………………………………………

………………………………………………………………………………………

……..

$For\ example\ \sqrt[3]{1.9320}\ =\ 1.2455$

THE FLOAT

A float is a non-measured whole number or constants like $1,2,\pi,e,etc.$

They are considered to have infinite number of significant figures e.g., 20 can be written as 20.00000…. hence having infinite number of sf.

When.

Note that

Example

If $t\ =\ 19.5$ seconds is time for 20 oscillations, then period

T= $\frac{t}{20\ (float)} = \frac{19.5(3sf)}{20(float)} = 0.975\ seconds$

Exercise

Given that $x\ =\ 23.5, T\ =\ 1.925,$

Compute

i. $\frac{1}{x}$

ii. $\frac{10}{x^2}$

iii. obtain t if T= $\frac{t}{20}$

MANIPULATION OF EXPERIMENTAL RESULTS IN MAIN TABLE OF RESULTS

Single (non - repeated values) or non - varying values.

i. These should be measured once and recorded outside the main table of results. Attach the corresponding unit to such values e.g., balancing point $G = 48.9cm$

For example, a simple table is designed as below

Let the diameter of the wire be d

d_1 (cm)	d_2 (cm)	d_3 (cm)
…………………	…………………	…………………

$$d = \frac{(d_1 + d_2 + d_3)}{3}$$

Note

The average value obtained should be recorded to the same number of dp as that of the least count of the instrument used. That is, maintain the degree of accuracy (dp) of the instrument being used.

***In the main table of results, only varying values are tabulated* as follows**

i. Independent variables should be entered in the first column followed by measured values followed by
ii. Units are put once at the top at the top of each column where applicable in brackets, ()
iii. Do not put equations when

RULES OF DATA MANIPULATION IN THE MAIN TABLE OF RESULTS

The following rules should guide you when manipulating data in the main table of results.

ADDITION AND

When adding or subtracting values from two different columns, consider the leading (first) pair of those values, carry out the operation and write the answer to the same number of dp as that of least accurate. That is maintain the least number of dp. This fixes the number of dp in the column of calculated values being added or subtracted.

Example

Copy the table below and include values of uv and $u + v$

$u(cm)$	$v(cm)$
2.5	99.5
5.0	93.5
7.5	88.5
10.0	76.0
12.5	67.0
15.0	46.5

Solution

$$2.5(1dp) + 99.5(1dp) = 102.0(1dp)$$

u(cm)	v(cm)	(u + v)(cm)	(u − v)(cm)
2.5	99.5	102.0	97.0
5.0	93.5	98.5	88.5
7.5	88.5	96.0	81.0
10.0	76.0	86.0	66.0
12.5	67.0	79.5	54.5
15.0	46.5	61.5	31.5

DEALING WITH VALUES FROM A SINGLE COLUMN

For reciprocal, multiplication or division with a float, squares, cubes, roots (e.g., square roots, cube roots etc.), you are dealing with values of a single column.

The number of significant figures of the largest value in a column is

Example.

Copy the table below and include the values of $y(m), \frac{1}{x}\ (m^{-1}), y^2\ (m^2)\ , \frac{y}{20}(cm)$

$x(m)$	$y(cm)$
0.05	26.1
0.10	31.0
0.15	38.0
0.20	45.0
0.25	53.2
0.30	62.0

Solution

x(m)	y(cm)	y(m)	$\frac{1}{x}(m^{-1})$	$y^2(m^2)$	$\frac{y}{20}$ (cm)
0.05	26.1	0.261	20.0	0.068	1.31
0.10	31.0	0.310	10.0	0.096	1.55
0.15	38.0	0.380	6.7	0.144	1.90
0.20	45.0	0.450	5.0	0.203	2.55
0.25	53.2	0.532	4.0	0.283	2.66
0.30	62.0	0.620	3.3	0.384	3.10

62.0 is largest in this column with 3sf. Hence $\frac{62.0\,(3sf)}{100(float)} = 0.620(3sf, 3dp)$

In x, 0.30 is largest with 2sf. Hence $\frac{1(float)}{0.30(2sf)} =$ $3.3(2sf, 1dp)$

In column of y, 0.620 *is largest with* $3sf$ Hence $0.620^2 = 0.384, (3sf, 3dp)$

in column of y (cm), 62.0 is highest with 3sf. Hence $\frac{62.0(3sf)}{20(float)}=$ 3.10(3sf,2dp

MULTIPLICATION AND DIVISION OF VALUES FROM TWO DIFFERENT COLUMNS

For multiplication or division of values from two different columns, identify a pair of values

Example. 1

Copy the table below and include the values of $xy\ and\ \frac{x}{y}$

$x(cm)$	$y(cm)$
0.05	0.261
0.10	0.310
0.15	0.380
0.20	0.450
0.25	0.532
0.30	0.620

Solution

$x(cm)$	$y(cm)$	$xy(cm^2)$	$\frac{x}{y}$
0.05	0.261	0.01	0.19
0.10	0.310	0.03	0.32
0.15	0.380	0.06	0.39
0.20	0.450	0.09	0.44
0.25	0.532	0.13	0.47
0.30	0.620	0.19	0.48

$\boldsymbol{In\ columns\ of\ x\ and\ y, the\ pair}$

$\boldsymbol{that\ gives\ largest\ product\ is\ (0.30, 0.620).}$

$\boldsymbol{Hence}$

$\boldsymbol{0.30(2sf) \times 0.620(3sf) = 0.19(2sf, 2dp)}$

$\boldsymbol{In\ columns\ of\ x\ and\ y, the\ pair}$

$\boldsymbol{that\ gives\ largest\ quotent\ is (0.30, 0.620)}$

$\boldsymbol{Hence}$

$$\boldsymbol{\frac{0.30(2sf)}{0.620(3sf)} = 0.48(2sf, 2dp)}$$

Note

- For repeated measured values, try to carefully repeat the procedures that gave constant values so that you get different values
- For calculated values in a column, increase the number of decimal points by one.

Example. 2

Copy and complete the table below

$i(°)$	$r(°)$	$x\ (cm)$	$sini$	$cosr$	$xcosr$	$logx$
20	11	1.0	0.342	0.982		
30	16	1.2	0.500	0.961		
40	20	1.4	0.643	0.940		
50	25	1.8	0.766	0.906		
60	31	2.0	0.866	0.857		
70	38	2.8	0.940	0.788		

Exercise on data manipulation in the main table of results

1) Complete the following tables

a)

b)

l(cm)	*l(m)*	$\frac{1}{l}(m^{-1})$
40.0		
50.0		
60.0		
70.0		
80.0		
100.0		

c) ***In the table below, t is time for 20 oscillations***

d)

$u(cm)$	$v(cm)$	$\frac{u}{v}$	$(u+v)(cm)$	$uv(cm^2)$
31.2	8.9			
29.6	11.9			
26.3	13.3			
24.1	15.2			
22.9	17.1			
19.0	21.0			

c)

2) Given the table below

$i(°)$						
$r(°)$						
$x(cm)$						
$y(cm)$						

Rearrange the table above in column form and include values of $xy, \frac{x}{y}, x^2, y^2, cosr, sinr, tani \text{ and } \frac{x^2}{y^2}$. Use the space provided below.

GRAPH WORK

A graph is preferred in a physics practical to make analysis of experimental results. This is because, it is considered most accurate method of data analysis.

When drawing a graph in physics practical, take note of the following key features of a good physics graph

Title (heading)

Write the title of your graph in the first square line of your graph paper. It should be well balanced in a middle of that line. Use small letters and do not underline your title. Do not put units in your title. An example of a title is

A graph of $sini$ against $sinr$

Drawing and labelling of axes

- ❖ The axes should be clearly drawn putting in consideration of the nature of data you are to plot. This helps you to plan for your graph paper properly. The axes must slightly cross and

Scales.

- ❖ The scale to be used must be a convenient scale which is picked from 1,2 or 5 including their multiples and sub multiples
- ❖ The scale to be used should be picked from the scale chart below that is based on special multiples and sub multiples of 1,2 and 5

1000	2000	5000	
100	200	500	$\times$ **10**
10	20	50	
1	2	5	
0.1	0.2	0.5	
0.01	0.02	0.05	$\div$ **10**
0.001	0.002	0.005	

- ❖ A scale of 2.5 including its multiples and submultiples ….
- ❖ Once a scale is picked, its number of dp should be maintained when labelling axes with values
- ❖ The obtained scale is
- ❖ When a value is read from a given axis, ***it should be recorded to the same number of dp as that of each small division*** (least count) on that particular axis.

Calculation of scales

a) When no intercept is needed

An intercept is the point on a given axis at which the line of the best fit cuts that axis

When no intercept (s) is required from your graph, the scales are obtained as follows

$$vertical\ scale = \frac{highest\ value - least\ value}{10}$$

$$horizontal\ scale = \frac{highest\ value - lowest}{8}$$

If the answer obtained is not exactly 1, 2 or 5, then it must be approximated upwards so that we take the next higher convenient value that is either a multiple or submultiple of 1,2 or 5

When intercept(s) are needed

Intercept may be required on one of the axes or on both axes

Cases where intercepts are required, the scales are obtained as follows

i. Vertical intercept

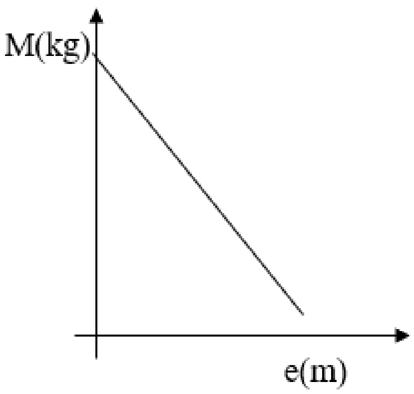
When an *intercept is required on vertical axis*, the horizontal axis must start from zero. You assume that the least value on horizontal axis is zero.

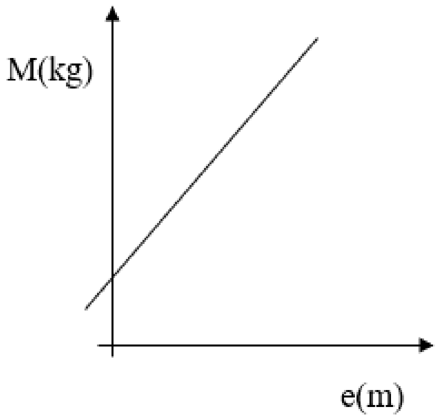
The scales are obtained as follows

- $vertical\ scale = \frac{highest\ value - least\ value}{10}$. You must look for a suitable starting value
- $horizontal\ scale = \frac{highest\ value - zero\ (0)}{8}$. The starting value of horizontal axis is strictly zero

When correctly plotted, and the line of the best fit produced so that it cuts the vertical axis,

The resulting graph may look as that shown below





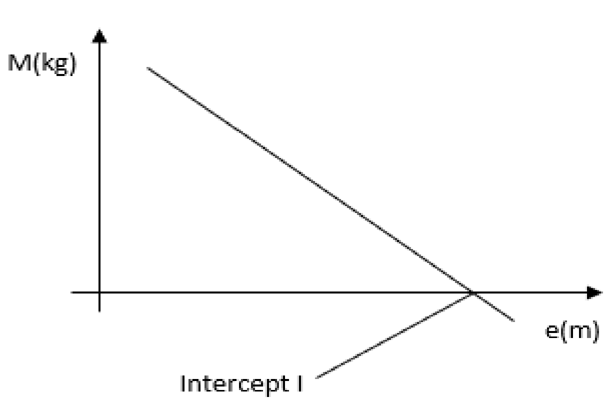
The point where the line of the best fit cuts the vertical axis is the intercept to be recorded

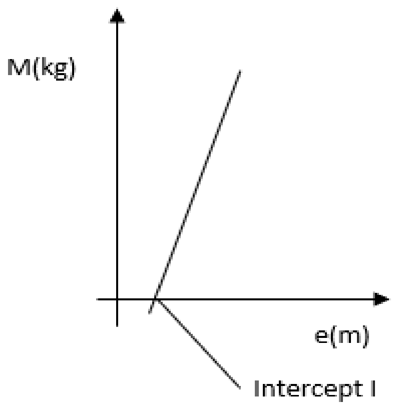
ii. Horizontal intercept

When an *intercept is required on horizontal axis,* the vertical axis must start from zero. You assume that the least value on vertical axis is zero. The scales are obtained as follows

- $vertical\ scale = \frac{highest\ value - zero}{10}$. The starting value of vertical axis is strictly zero,0
- $horizontal\ scale = \frac{highest\ value - lowest\ value}{8}$. You must look for a suitable starting value

When correctly plotted, and the line of the best fit produced so that it cuts the horizontal axis, the resulting graph may look as that shown below



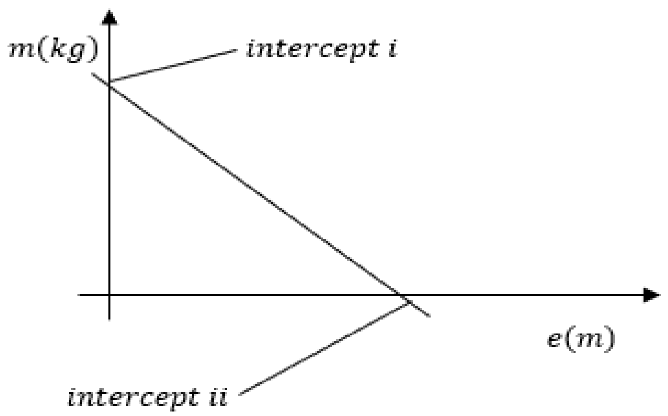


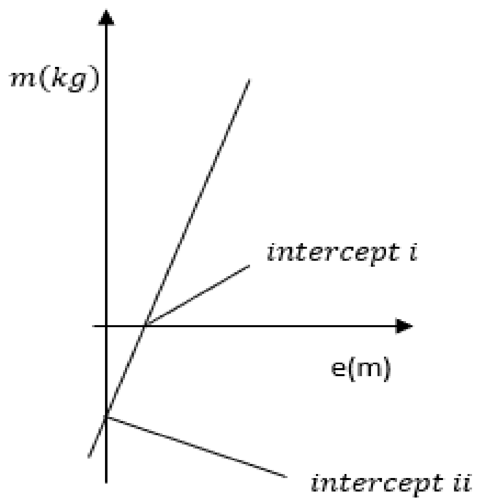
iii. **Intercepts on both axes**

When the *intercept is required on both axes*, both axes must start from zero. Both scales are obtained as follows

- $Vertical\ scale = \frac{highest\ value - zero}{10}$,
- $Horizontal\ scale = \frac{highest\ value - zero}{8}$

When correctly plotted, and the line of the best fit produced so that it cuts both axes, the resulting graph may look as that shown below





Starting values.

- ❖ Each axis must be having its own starting value that is a multiple of the convenient scale to be used on that axis.
- ❖ The number of decimal places used on a given axis should be equal to the number of dp of your scale.
- ❖ At the end of each axis, put an arrow to show the direction of increasing or decreasing values.

How to obtain the starting value

- ❖ The starting value should be a multiple of the scale you have chosen to use. It should be close (not very close and not very far) from least value in the table. It should be to the same number of dp as your scale.

Follow the following steps to get the starting value

i. On your calculator, press zero, then equal signs then add button, then your scale then equal signs again

(0 = + scale =)

ii. At this stage, you have your scale on the screen

Plotting

- ❖ The values should be accurately plotted.
- ❖ Note that you should not assume the position of the values to be plotted.
- ❖ You should also not round off the values in the table of results so that they become easy to plot.

To locate position of a value to be plotted, use any of the following methods

Method 1

$$Position\ of\ value\ to\ be\ plotted = \frac{value\ to\ be\ plotted - starting\ value\ on\ that\ axis}{value\ of\ each\ small\ division\ on\ that\ axis}$$

This gives you the number of small divisions you are to count from starting point up to the position of the value to be plotted.

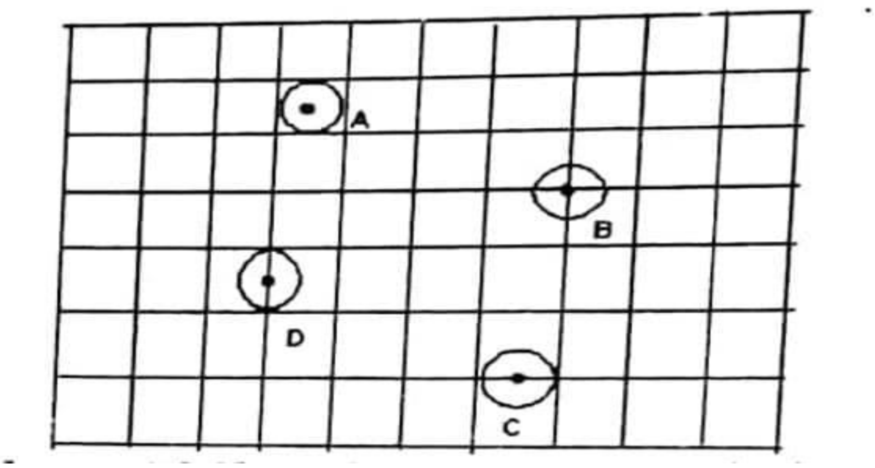
Method 2

This gives you the number of small divisions to count from the value just below the value to be plotted to the position of the value to be plotted

NOTE

i. The value of each $small\ division\ (least\ count)\ = \frac{scale\ on\ a\ given\ axis}{10}$.

ii. When plotting, use a dot with a small circle around it as illustrated in the square grid below.



The small circle around the dot should be drawn as guided below

- If the dot is at the point of intersection of lines of the squares e.g., dot B, the circle should be drawn such that it passes through the halves (centres) of small squares on either side of the dot
- If the dot is in the middle of the square e.g.dot A, the circle should not go beyond that square. It should be within the boundaries of the square
- If the dot lies on the vertical line e.g., dot D, the circle drawn should be within the boundaries of the upper and lower lines but it should not touch the neighboring vertical lines
- If the dot lies on the horizontal line e.g., dot C, the circle drawn should be within the boundaries of vertical lines but it should not touch the neighboring horizontal lines

The line of the best fit

- This should be drawn so that it follows the trend of the points plotted
- It may pass through all the points plotted, or passes

Drawing triangle

- The triangle used in getting values to be used in calculation of slope should be drawn in a such way it is a **right-angled triangle** and it encloses all the points plotted. No plotted point should lie outside of this triangle.
- It must cross the line of the best fit at one of the points where small squares meet the line of the best fit.
- The triangle is drawn using a solid line (recommended) or dotted lines.

NOTE

i. When values of two columns to be plotted are such that, values in one column are increasing as the values in the other column decrease, expect a graph with negative slope or gradient

ii. If values in columns being plotted … expect a graph with a positive slope

Calculation of slope

- Values to be used in calculating the slope are directly read from your graph

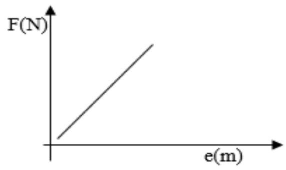
The slope is then obtained from

$$\text{Slope} = \frac{change\ in\ values\ of\ vertical\ axis}{change\ in\ values\ of\ horizontal\ axis}$$

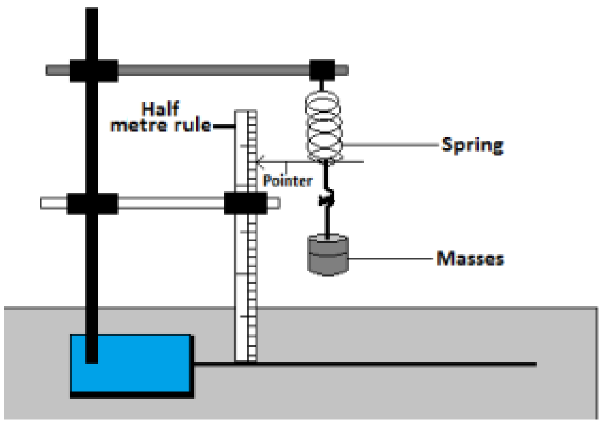
- The units of the slope should be derived from the graph. For example, if $T^2(s^2)$ was plotted against e(m), the units of slope would be s^2m^{-1}

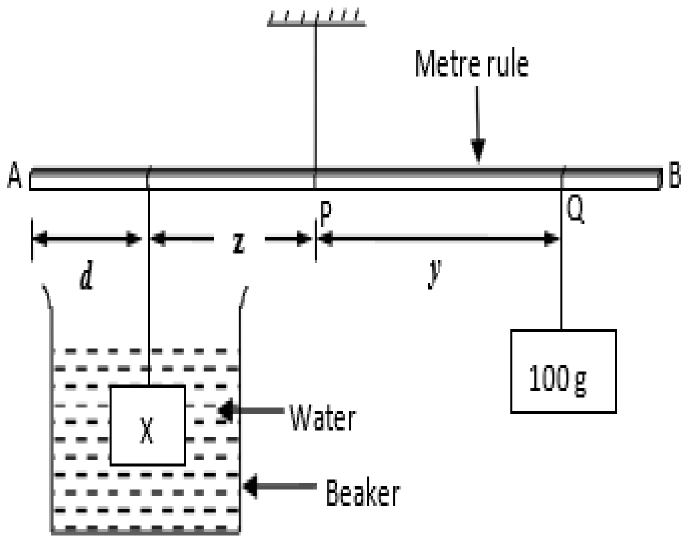
When the slope is obtained, it can be substituted in a suitable formula to draw conclusions

THEORY OF COMMON EXPERIMENTS IN PHYSICS

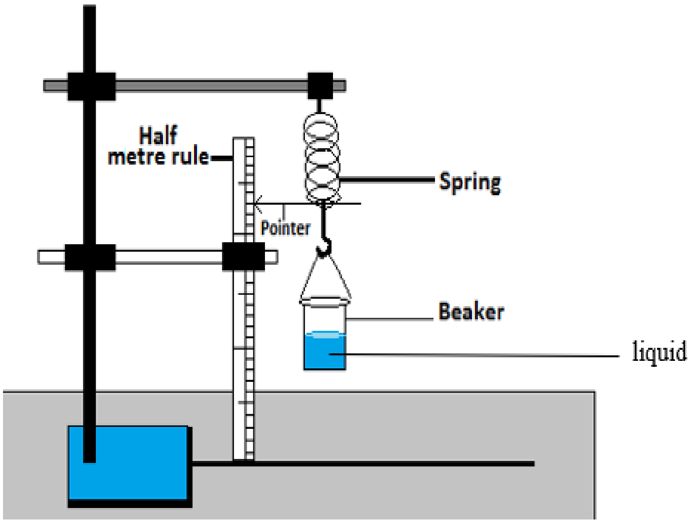
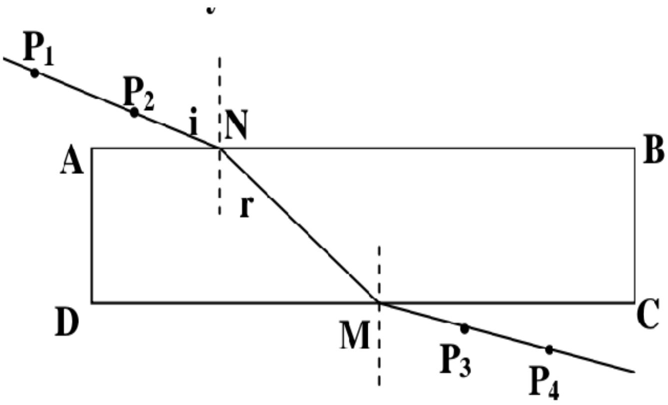
A scientific investigation to	Transformed equation in form $y = mx + c$. For intercept $c = 0, then\ y = mx$	Variable on		Shape of expected graph and slope, s
		vertical axis	horizontal axis	
$(\boldsymbol{a})$ determine the spring's constant k of a spring Theory. From hooks' law, extension of an elastic material is proportional to the applied force provided the elastic limit is not exceeded. Hence $F \propto ke$; $F = ke$	$F = ke$ where F is wight/force in newtons (N) and e is extension in metres (m)	F	e	 slope $s = force\ constant\ k$ $s = k\ in\ Nm^{-1}$ Note that a graph of e against F can be plotted if your transformed equation is $\mathbf{e} = \frac{1}{k}\boldsymbol{F}$ slope $S = \frac{1}{k}$ hence $k = \frac{1}{s}$

DIAGRAMS (SET UP) OF SOME COMMON EXPERIMENTS IN PHYSICS

<table>
<tr><td>Experiment</td><td>possible set up or diagram</td></tr>
<tr><td>To determine the force constant of a spring
OR: To determine the acceleration due to gravity g using a loaded spring</td><td>


</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>To determine the relative density or density of a solid
$R.D = \frac{m_a}{m_a - m_w}$
m_a is mass of solid in air, m_w is mass of solid in water got from
$m_w = 100s$ where s is a slope of a graph of z against y</td><td>


</td></tr>
</table>

To determine relative density or density of a liquid e.g., oil or paraffin	
To determine the refractive index of a glass block	

EXAMPLES ON DATA MANIPULATION, PLOTTING A GRAPH AND FINDING SLOPES

Example 1

In a scientific investigation to determine the refractive index of a glass block, the student obtained the following angles of refraction $r(°)$ for respective angles of incidence $i(°)$

$i(°)$	$r(°)$
10	5
20	15
30	20
40	24
50	31
60	37

Tasks

a) Copy the table above and include columns with values $sini, sinr, \frac{1}{sin^2 i}$ and $\frac{1}{sin^2 r}$.

b) Plot a graph of $sini$ against $sinr$

c) Obtain the slope of your graph.

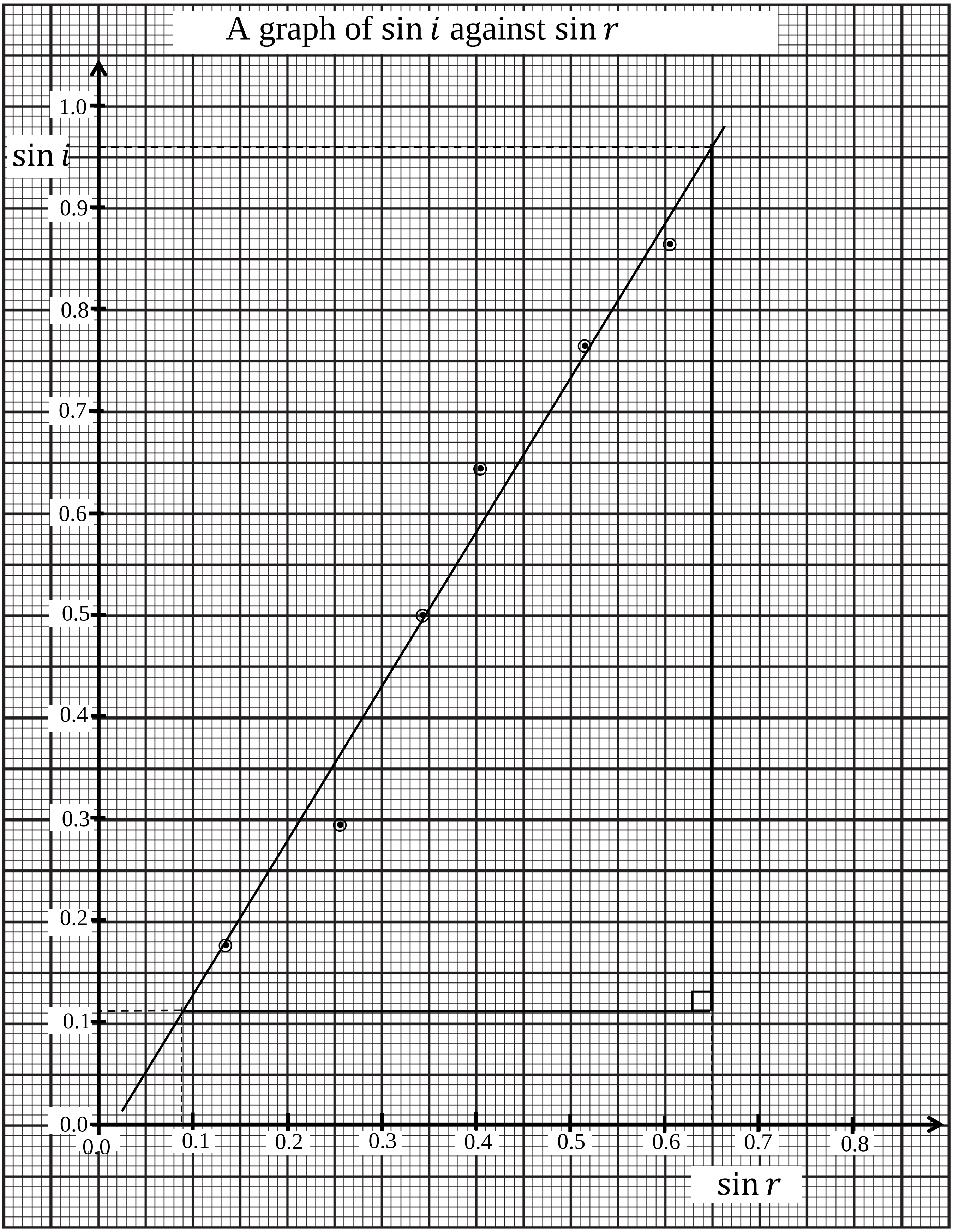
d) comment on the value of slope obtained

Responses

a)

$i(°)$	$r(°)$	$sini$	$sinr$	sin^2i	sin^2r	$\frac{1}{sin^2i}$	$\frac{1}{sin^2r}$
10	8	0.174	0.139	0.030	0.019	11.49	52.63
20	15	0.342	0.259	0.117	0.067	8.55	14.93
30	20	0.500	0.342	0.250	0.117	4.00	8.55
40	24	0.643	0.407	0.413	0.166	2.42	6.02
50	31	0.766	0.515	0.587	0.265	1.70	3.77
60	37	0.866	0.602	0.750	0.362	1.33	2.76

b)


A graph of sin i against sin r
sin i
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
sin r

c) From the graph

$slope\ s = \frac{\Delta sini}{\Delta sinr}$

$s = \frac{0.96-0.11}{0.64-0.09}$

$s = \frac{0.85}{0.55} = 1.5$

d) From Snell's law of refraction of light, $n = \frac{sini}{sinr}$ $hence\ sini = nsinr$ which is in the form $y = mx + c\ for\ c = 0$

Hence the slope s of graph of $sini$ against $sinr$ is equal to refractive index of a material (glass block)

Therefore, $n = 1.5$

Example 2

In an attempt to determine the value of the acceleration due to gravity using a swinging pendulum bob, a senior three student carried out a scientific investigation and obtained the following. *h is the height of the pendulum above the reference level (ground) and* t *is time for 20 oscillations*

$h(m)$	$t(s)$
0.100	47.5
0.200	45.5
0.300	43.0
0.400	40.0
0.500	37.5
0.600	35.5

Tasks

Using experimental results above,

a) copy the table and include the values of T^2 where T is the period

b) Plot a graph of T^2 against h

c) Obtain the slope s of the graph

d) Use the slope s in (c) above to obtain the value of acceleration due to gravity g from $g = \frac{4\pi^2}{-s}$

PRECAUTIONS INVESTIGATION

Precautions are measures taken to prevent or minimize the risks of harm and also to improve on the accuracy of experimental results

Precautions in mechanics experiments

For experiments involving oscillations (e.g., oscillation of loaded spring or swinging pendulum bob)

- ❖ The length of the pendulum should be measured from the point of suspension to the middle of the bob

  For experiments in light

- ❖ The surfaces of mirrors or lenses should be thoroughly clean.
- ❖ The mirror or lens should be vertically fixed firmly in their holders using small pieces of plasticine
- ❖ The intensity of light in the room should be natural and constant. This enables an image to be easily formed on the screen
- ❖ The illuminated object should be at the same level as that of a pole of concave mirror or an optical center of convex lens
- ❖ The screen on which an image is to be formed should be purely white

When using optical pins

- ❖ The optical pins are fixed such that they are equally spaced and vertically upright
- ❖ The object pins are fixed in a straight line

For experiments in electricity

- ❖ Avoid loose connections at

Note

In all experiments that involve taking a reading from the scale of instrument, avoid parallax errors by making sure that the line of view is perpendicular to the point being read off from the scale.

WORKED EXAMPLES OF SCENARIO BASED ITEMS

Item 1

Scenario

SCENARIO ITEMS FROM MECHANICS

Item 2

Scenario

A cleaner has been instructed to use a uniform wooden rod of mass in the range of 260g to 700g to hang clothes for swimming participants. The cleaner buys a rod of unknown mass from a carpenter. The cleaner has no weighing scale to measure the mass of the rod hence she is not sure whether the bought rod meets the required specification.

The cleaner calls you to come and help her to determine the mass of the rod without using a weighing scale

You are provided with a uniform metre rule whose mass is **four times less** than the mass of the rod

Task

As a physics learner, help the cleaner to determine the mass of the uniform rod and advise her whether or not the rod is suitable to be used for hanging clothes of swimming participants

Item 3

Scenario

In a certain district, there exists a family that rely on a lamp with burning paraffin to produce light to aid in vision at night. Recently the quality of paraffin the family members buy from nearby shop has reduced. In addition to dim light, it produces a lot of soot when burning. Such dense soot is harmful to respiratory system of a man. Pure paraffin has density that lies between $0.75gcm^{-3}$ and $0.85gcm^{3}$

You are a member of that family and your provided with a sample of paraffin being used in the lamp

Task

As a physics learner, carry out a scientific investigation on a sample of paraffin provided and advise the family members appropriately

SCENARIO ITEMS FROM LIGHT

Item 10

Scenario

The lens in your school's projector

Item 11

Scenario

A man was driving his car through a heavy jam on Kampala Road. Accidentally motor cyclist knocked his car head lamp and broke it. The mirror inside the head lamp was damaged as well hence it needed replacement. The concave mirror used in the car head lamp has focal length of $15 \pm 1cm$ according to car's log book. The man has decided to take his car to nearby garage for repair.

At the garage, the mechanic has a concave mirror of unknown focal length and therefore he is not sure whether or not it is suitable to be used in repairing man's car head lamps. The mechanic approaches you to help him identify the exact focal length of his mirror.

You are provided with a concave mirror, the mechanic had at the garage

Task

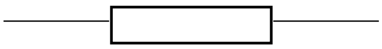
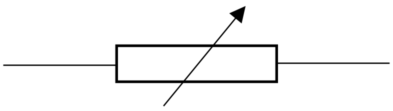
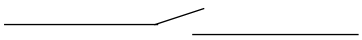
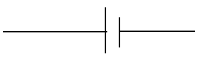
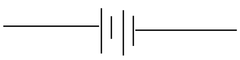
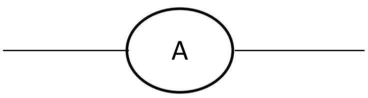
As a physics learner, determine the focal length of the concave mirror provided and advise the mechanic whether or not it is suitable to be used in repairing the man's car head lamp

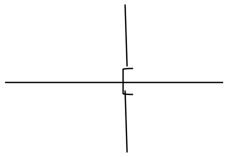
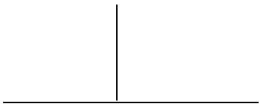
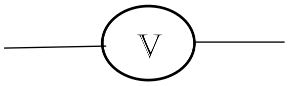
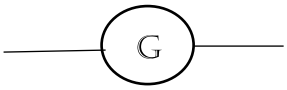
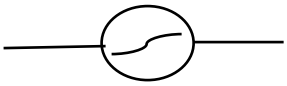
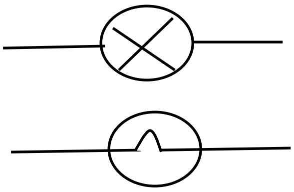
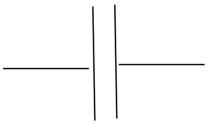
CURRENT ELECTRICITY

Electric current is the rate of flow of charges through the conductor. Current flows in a closed electric circuit that is made up of different electrical components such as resistors, dry cells, wires, ammeters, voltmeters etc. Therefore, a candidate is supposed to arrange and connect appropriate electrical components so as to come up with a closed-circuit diagram that allows current to flow.

In a circuit diagram, electrical components are represented by their standard symbols as given in the table below

ELECTRICAL SYMBOLS OF COMPONENTS USED IN ELECTRIC CIRCUITS

Electrical symbol	**Name**
	standard resistor
	Variable resistor /rheostat
	Switch
	cell
	battery (combination of cells)
	Ammeter

	crossing wires
	connected wires
	voltmeter
	Galvanometer
	alternating current supply
	bulbs/lamp
	capacitor

Note

- ❖ In all circuit diagrams, an ammeter should be connected in series with the component so as it reads the current through that component
- ❖ The voltmeter should be connected across (in parallel with) the component so that it reads the potential difference (voltage) across that component

SCENARIO ITEMS FROM ELECTRICITY

Item 12

Scenario

The physics laboratory technician is preparing a simple practical exam for senior four class. She has been presented with a confidential having an instruction that each candidate should be given one fresh dry cell of internal resistance not exceeding 1.5Ω. She faces a challenge of how to determine the internal resistance of available fresh dry cell in the box. She approaches you for assistance. She gives you one dry cell which is a sample of available fresh dry cells in the box

Task

As a physics learner, advise the laboratory technician whether she should or should not give the available dry cells in the box to students

Item 21

Scenario

EXAMPLE OF SCORE GRID (MARKING GUIDE)

BASIS OF ASSESSMENT	CODE	CRITERIA	CODE	SCORE	SUBTOTAL SCORE
Aim of the experiment	A	Properly stated aim with all key words	A_1	02	02
		aim with missing key words	A_2	01	
		no aim stated	A_0	00	
Variables	V	correct independent (manipulated)variable	V_{I1}	01	01
		Not stated/incorrect independent (manipulated) variable	V_{I0}	00	
		correct dependent (responding) variable	V_{D1}	01	01
		Not stated/incorrect dependent (responding) variable	V_{D0}	00	
		Correct fixed variable	V_{C1}	01	01
		incorrect/not stated fixed variable	V_{C0}	00	
Hypothesis	H	Correctly stated hypothesis with all key words and related to the aim	H_1	01	01

		Incorrect/no/not related to the aim hypothesis stated	H_0	00	
List of apparatus	AP	All relevant apparatus listed	AP_1	02	02
		A few of relevant apparatus listed	AP_2	01	
		No/irrelevant apparatus listed	AP_3	00	
Experimental set up (diagram)	D	Well, labelled correct/working diagram	D_1	02	02
		Partially labelled but a working diagram	D_2	01	
		No diagram	D_3	00	
Procedures or steps	P	Correct(relevant) procedures	PR_1	02	04
		partially correct	PR_2	01	
		Not correct or no procedure given	PR_3	00	
		coherent procedures	PC_1	02	
		partially coherent	PC_2	01	
		not coherent	PC_3	00	
Data presentation	DP	Correctness of data presentation			07
		correct data presentation	DPc_1	02	
		partially correct data presentation	DPc_2	01	

		wrong/no data presentation	DPc_3	00	
		Recording of data			
		correct data recording	DPr_1	02	
		partially correct data recording	DPr_2	01	
		no/incorrect data recording	DPr_3	00	
		sets of data			
		maximum required data presented	DPs_1	03	
		half of data presented	DPs_2	02	
		one data point presented	DPs_3	01	
		no data presented	DPs_4	00	
Accuracy of data	Ac	Data recorded lies within accepted range	Ac_1	02	02
		Data recorded lies slightly out of accepted range	Ac_2	01	
		Data recorded is completely out of expected range	Ac_3	00	
Data analysis	DA	Data analysed using appropriate method e.g., graph	DA_1	02	02
		Data analysed using partially method	DA_2	01	

		Data analysed using un appropriate method	DA_3	00	
Data interpretation	DI	correct data interpretation	DI_1	02	02
		partially correct data interpretation	DI_2	01	
		No correct data interpretation	DI_3	00	
Conclusion		conclusion based on interpretation	C_1	02	02
		conclusion partially based on interpretation	C_2	01	
		no or irrelevant conclusion	C_3	00	
Advice	Ad	correct/relevant advice based on findings	Ad_1	01	01
		no advice /irrelevant advice	Ad_2	00	
Risks/errorns	E	two or more sources of errors given	E_1	02	02
		one source of error given	E_2	01	
		no source of error given	E_3	00	

Precautions or mitigation of errors	M	all mitigations to stated sources of errors given	M_1	02	02
		fewer mitigations given	M_2	01	
		no mitigation or precaution given	M_3	00	
TOTAL SCORE					34
Note that; the number of scores awarded at each stage is bound to change depending on the nature of the task. The codes and total score may therefore change accordingly.					

SUMMARY OF MARKING GUIDE AS OF 2024 UNEB PHYSICS PRACTICAL PAPERS

Basis	Code	Maximum weights
Aim and purpose		
variables		
hypothesis		
procedures (list of apparatus, diagram, procedures/steps)		
sources of errors and mitigations/precautions		
presentation of data		
recording of data with accuracy		
data analysis and interpretation (graph work)		
conclusion and advice		
Total weights	T/W	38