Guide to physics practical

Physics practical is aimed at

- Train learners on how to make measurement with common equipment in the laboratory and real life. In real life measurement such those of mass and volumes are very common in shops, kitchen etc.; measurement of length are employed by tailors, surveyors, welders, carpenters; measurement of temperature is common in hospitals by doctors and nurses, weather stations and in industries while measurements of time are very common in school timetable, games such football, examinations, cooking to mention but a few. It therefore imperative, that students are conversant with these and other measuring equipment to pass exams but also to succeed in life.
- To equip learners with manipulation skill such cutting, reading, balancing moments, tying, counting, etc. For instance tying is very common in real life such tethering animals, fastening bridges, tying hanging wires for clothes, etc.
- To train learners in the recording and presentation scientific data. Note that examiners mark recorded data rather practical operation although, practical record is a mirror of logical performance of the practical. Much of this guide is based on proper recording of experimental data to obtain the highest mark possible. Note that there are approved rules concerning physics practical report.

Rules of presentation of data

1. The table of results

- **Title:** The table should have a title: for instance, “ A table of results”
- **Structure:** The table is supposed to be columnar with the labels placed in the first row.
- **Recording units of each label in the table: units of the head row** must be written in brackets rather with forward slash such as **t(s) NOT t/s.** For example,

t(s)	T(s)	F(Hz) or f(s^{-1})

- **Abbreviation of unit measures**: Use standard abbreviation; small letters must be distinguishable from capital letters. Some the abbreviations of common units are given in the table below

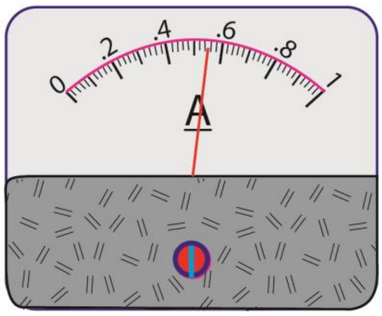
Measurements	Abbreviation	
	correct	Common mistakes
Metres	m (small m)	M
Kilogram	kg (small k, smallg)	Kg or kG
Seconds	S (small s)	S, sec
Volts	V (capital V)	V
Ampere	A (capital A)	Amps
Kelvin	K (capital K)	k
Kilogram per second	kgs^{-1}(k, g, s are small letters)	Kgs^{-1}
Kelvin gram per second	Kgs^{-1} (K is capital, g and s are small letters)	KgS^{-1}

- **The number of columns in the table:** is determined by what the question demand to be recorded.
- **Use of a pencil.** A pencil **must not** be used to enter data into the table nor titles and labels on the graph but may be used may be used to draw axes and mark points on the graph. If possible do not use a pencil at all.
- **Number of decimal to which the measured value is to be recorded.** The least count or least possible scale value on the instrument being used is considered. A metre rule for example, reads to 1dp in centimetres such 0.1cm, 3.6cm, 49.9cm, 20.0cm etc; readings of metre rule in meters are thus of 3 decimal places metres; such as o.001m, 0.101m, 0.255m, 1.000m etc; a digital stop clock reads to 2dp in seconds such as 44.06s

  Midpoint estimation: is the smallest acceptable recordable unit for all measuring instruments except for metre rule. For instance,

Each division =5/5 =1s
Reading: 12.5s

Each division =1/10 =0.1V
Reading: 0.85V



Each division 0.2/10 = 0.02
Reading 0.55A

It is advisable to estimate the midpoint readings **only when** consecutive measurements areshowing constant readings.

2. Significant figures

Significant figures are the digits in a number that carry **meaning** about its precision. That includes:

- **All non-zero digits**
- **Zeroes between non-zero digits**
- **Trailing zeroes after a decimal point**
- *Leading zeroes*, however, are **not** significant—they just hold the decimal place.

Examples

Number	Sig Figs	Why
42	2	Two non-zero digits
0.0031	2	Leading zeroes don't count
4.500	4	Trailing zero after the decimal *is* significant
700	1 (or 2 or 3)	Depends on context (e.g. scientific notation)
1.00×10^3	3	Clear indication of 3 sig figs in standard form

Trial

Rewrite the following numbers to the number of significant figures shown in brackets

(a) 4500 (1) l5000]
(b) 5888 (3) [5890]
(c) 0.0485 (2) [049]
(d) 0.70008 (3) [0.700]
(e) 6.666 (3) [6.67]
(f) 0.00758 (1) [0.008]

Significant figures or decimal paces in calculatons

(i) Note that trailing zero is significant if:

- it represents the accuracy of an instrument e.g. l = 20.0cm has 3 s.f.
- a whole number of masses e.g. slot masses of 100g has 3s.f.
- it is due to rounding off a decimal number, e.g. rounding off of 4.3699 to 3d.p give 4.370. Here zero is significant.
- a float like 1000 is written to show a pricise number of significant figures as
  $1000 = 1 \times 10^3$ (1 s.f}
  $1000 = 1.0 \times 10^3$ (2 s.f)
  $1000 = 1.00 \times 10^3$ (3 s.f)
  $1000 = 1.000 \times 10^3$ (4s.f)

(ii) **In case of division ormultiplication with float (constant value with infintesignificant figures or decimal places:** significant figures (s.f) of the measured value should be used e.g
$\frac{40.25\ (4s.f}{20\ \text{(float)}})$ (in finding the period) = 2.013 (4 s.f)

(iii) **Division and multiplication with another measured value**: in this case the **quotient or product** takes the s.f of the value with least significant figures. E.g.

0.65 (2s.f) x 2.72 (3.f) = 1.8 (2s.f)

and

$$\frac{10.44(4s.f)}{5.25(3.s.f)} = 1.99(3s.f)$$

(iv) **Addition and subtraction of decimals:** The sum or difference take the value with the least number of d.p, e.g.
0.937 (3d.p) + 2.4 (2d.p) = 3.3 (2d.p)
7.95(2d,p) – 1.357 (3d.p) = 6.59 (2d.p)

(v) **Log and trignometric rato(in, cos, tan):** are truncated to 3 decimal places) e.g.

$\sin 20^0$	0.342
$\cos 80^0$	0.173
$\tan 30^0$	0.577
Log 26	2.354

(vi) Sgnficant figures in the table of results are generally decided bythe smallest figure in a column, however, the number of significant figures may be adjusted to avoid constant figures

I(a)	$\frac{1}{I}$ (A^{-1})	x(m)	y (m)	xy(m^2)	$\frac{x}{y}$	$\frac{x}{2y}$
0.40	2.5 (2s.f)	0.05	0.261	0.01 (1s.f)	0.19	0.10
0.36	2.8	0.10	0.310	0.03	0.32	0.16
0.32	3.1 (1d.p)	0.15	0.35	0.06 (2d.p)	0.39	0.20
0.28	3.6	0.20	0.45	0.09	0.44	0.22
0.24	4.2	0.25	0.53	0.13	0.47	0.23
0.20	5.0	0.30	0.62	0.19	0.48 (2s.f)	0.24

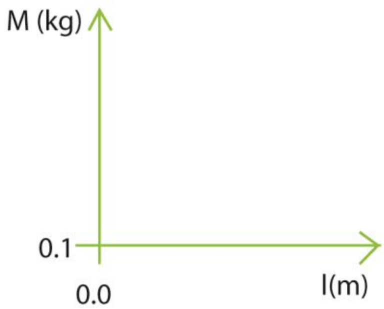
to avoid constant figures 2s.f are used instead of 1s.f as per row 2

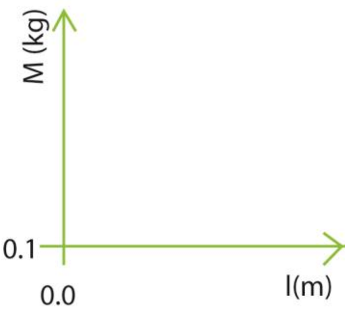
Graphs

Title: The title of the graph is writted with the use of “against”, Versus and “variation with”. The title **must not contain** units

Axes: The axes must be labelled and units should be in bracketss. E.g.

Araph of M against l or
A graph of M versus l or
The variation og M with l





Plotting:

- Plot with pen or pencil using (x), a dot (.) or acircle with a dot at the centre (ʘ).
- **Line of the best fit:** must pass pass through most the points and balance the remaining points on each side. It must all pass through the point (mean x , mean y)

Araph of M against l or
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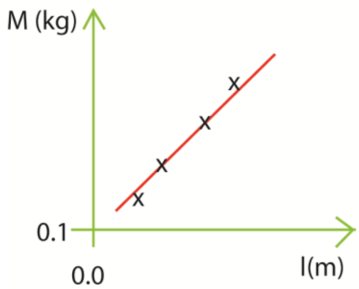

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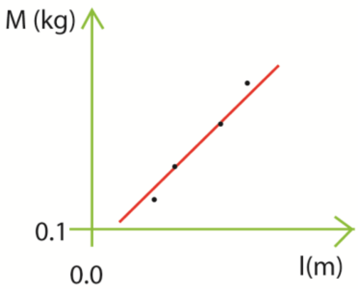

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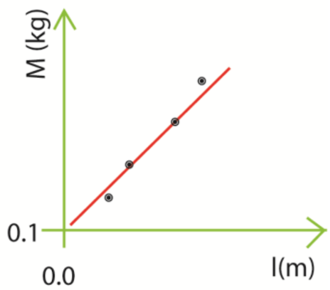

Scales:

- must be those that can easily read without using a calculator i.e. in multiples of 1, 2 and 5 and state the value on each axis which is the multiple of the scale used
- It must be chosen such that the graph must covers at least a half of the plotting space

Araph of M against l or
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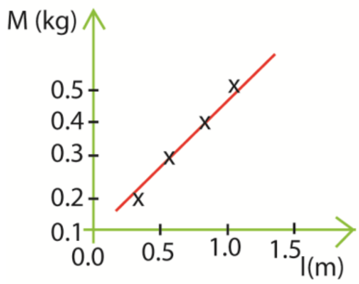

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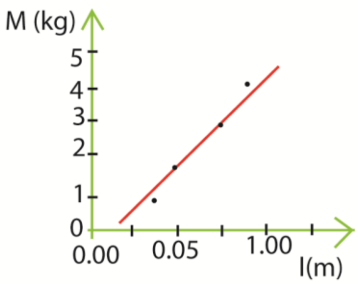

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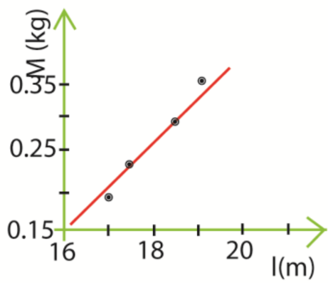


Guideline of how to determine the scale when the starting point is zero (0) or 0.0, 0.00 etc.

- Draw the axes and on each mark units (easiest with a unit = 10 smallest boxes)
- Count the number of units marked (e.g 8)
- Pick the biggest value to be plotted and divide it by the number of units marked on that axis.
- Then, scale is an approxinamate of the value slightly higher than the quotient but a multple of either 1, 2 or 5. A very big approximate higher than the quotient give a very small graph while an appromate lower than the quotient gives a graph that does not fit all the values

Example

No. of units marked (p)	Biggest value to be plotted (q)	Quotient $\left({}^{q}/_{p}\right)$	Appropriate scale
8	1.6	0.2	0.2
10	37	3.7	4 0r 5
7	6.52	0.93	1
8	0.94	0.1175	0.2
10	0.743	0.0743	0.1
8	0.621	0.077625	0.1

- **Plotting values in the table on agraph of a given scale; an axis starting with zero (0) and each unit = 10small boxes**
  (i) Divide the number to be plotted by the scale value.
  (ii) Locate the position of value on the axis by counting the units obtained in (i)
  Example

Value to be plotted (j)	Scale (k)	No. of units required $\left({}^{j}/_{k}\right)$
0.351	0.05	7.0 (count 7 units and put a small mark and plot it with the corresponding mark on the other axis; after erase these small marks so that they are not confued with plotted values)
0.94	0.2	4.7 (4units and 7 small boxes)
70	10	7.0

- **Finding the value of ploted point on an axis starting with value zero(0) and a unit of 10 small boxes:** count the number of units corresponding to the plotted value on an axis and multiply with the scale value

Number of unit (P)	Scale (q)	Value plotted
7.2	0.05	0.36
4.1	0.2	0.82
5	10	50

Guideline of how to determine the scale when the starting point is not zero

(i) Draw the axes and on each mark units (easiet with a unit = 10 smallest boxes)
(ii) Count the number of units marked (e.g 8)
(iii) Choose appropriated starting value slightly below the smallest value to be plotted. Note that all graph for which an intercept (s) is/are required must start from (0, 0)
(iv) Pick the biggest value to be plotted, subtract the starting value of your choice in (iii) above and divide the difference by the number of units marked on that axis.

- Then, scale is an approxinamate of the value slightly higher than the quotient but a multple of either1, 2 or 5. A very big approximate higher than the quotient give a very small graph while an appromate lower than the quotient gives a graph that does not fit all the values Example

No. of units marked (p)	Biggest value to be plotted (k)	Starting value (t)	Difference q (=k – t)	Quotient $\left({}^{q}/_{p}\right)$	Appropriate scale
8	1.6	1	0.8	0.2	0.2
10	37	20	17	7.7	2
7	6.52	4	2.52	0.36	0.4
8	0.94	0.6	0.34	0.0425	0.05
10	0.743	0.5	0.243	0.0243	0.025
8	0.621	0.3	0.321	0.040125	0.05

- **Plotting values in the table with a given scale on an axis starting with a value that is not zero(0) and each unit = 10small boxes**
  (i) Get the number to be plotted, subtract the starting value on an axis, divide the difference by the scale value.
  (ii) Locate the position of value on the axis by counting the units obtained in (i)
  Example

Value to be plotted (p)	Starting value (t)	Difference q (=p-t)	Scale (k)	No. of units required $\left({}^{q}/_{k}\right)$
0.711	0.5	0.211	0.1	2.1 (count 7 units and 1 small box; put a small mark and plot it with the corresponding mark on the other axis; after erase these small marks so that they are not confued with plotted values)
0.94	0.6	0.34	0.2	1.7 (1unit and 7 small boxes)
70	20	50	10	5.0

- **Finding the value of ploted point on an axis NOT starting with value zero(0) and a unit of 10 small boxes:** count the number of units corresponding to the plotted value on an axis and multiply with the scale value and add the start value of the axis

Number of unit (P)	Scale (q)	pq	Startng value on	Value plotted
7.2	0.05	0.36	2.0	2.36
4.1	0.2	0.82	1.5	2.32
5	10	50	10	70

Finding a slope

- Draw a right angled triangle covaring at least a half of the graph on one side of the line of the best ft.
- **The slope/gradient is calculated with values from the graph NOT from the table.**
- Values from the graph must be to the same number of decimal places as those of the scale
- Caculation are based on the rules of subtraction and division of decimal places and sgnificant figures

Example

A experiment to determine acceleration due to gravity

(d) time t for 20 oscillations = 43.96s

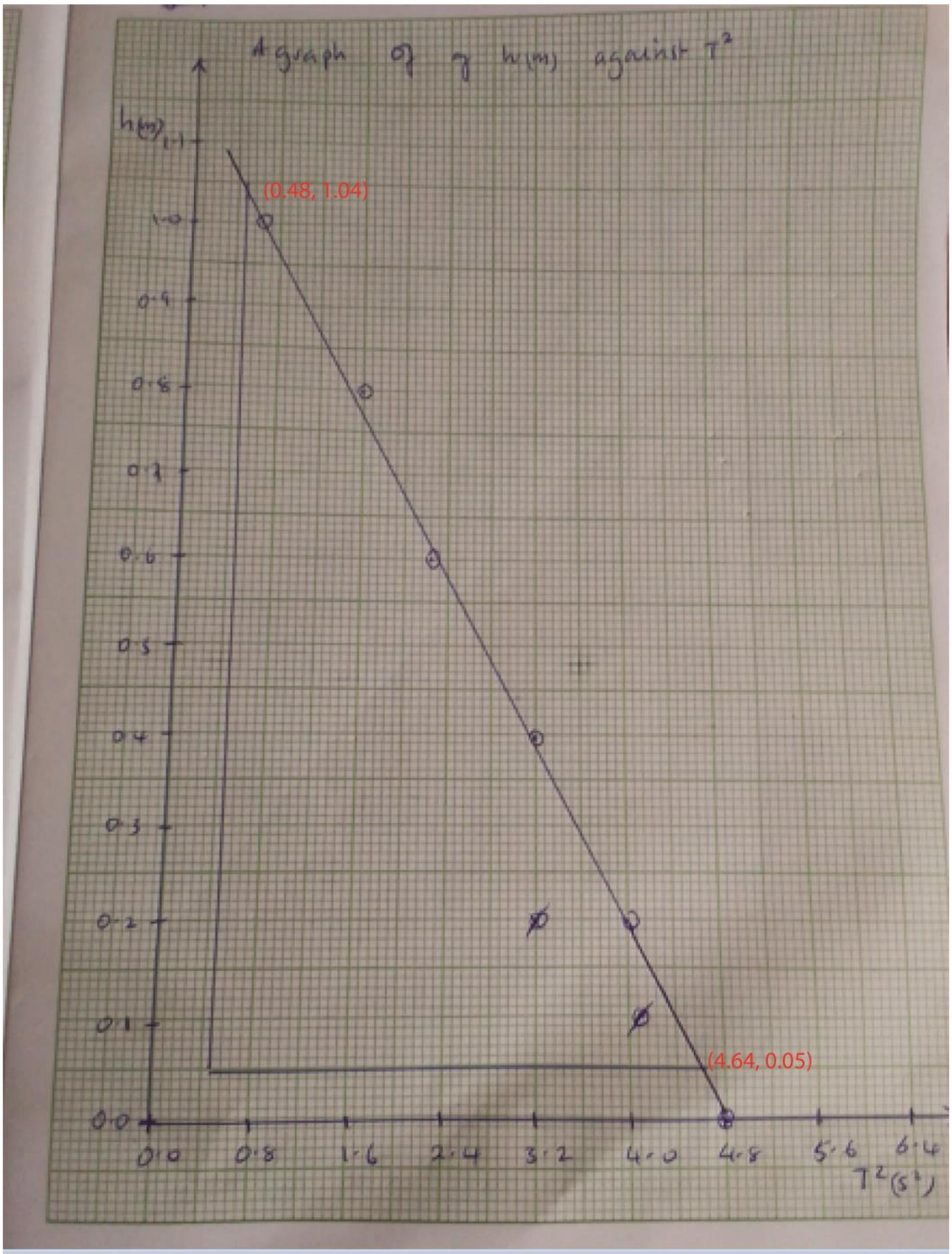
Period T (time for 1 oscillation) = $\frac{43.96\ (4s.f)}{20\ (float)}$ = 2.198s (4s.f)

(e) h = 0.2m

t = 40.19s

(g) Table of results

h(m)	t(s)	T(s)	$T^2(s^2)$
0.0	43.96	2.198	4.831
0.2	40.19	2.010	4.040
0.4	35.94	1.797	3.229
0.6	30.03	1.502	2.256
0.8	25.09	1.255	1.575
1.0	20.02	1.001	1.002



(i) Slope, s = $\frac{1.04\ (2d.p) - 0.05(2d.p)}{0.48(2.p) - 4.64(2d.p)}$

= $\frac{0.99\ (2s.f)}{-4.16(3s.f)}$

= -0.24 (2s.f)

(j) g = $-4\pi^2 s$

= -4 (float) x π2 (float) x -0.24 (2s,f)

= **9.5 (2s.f)**

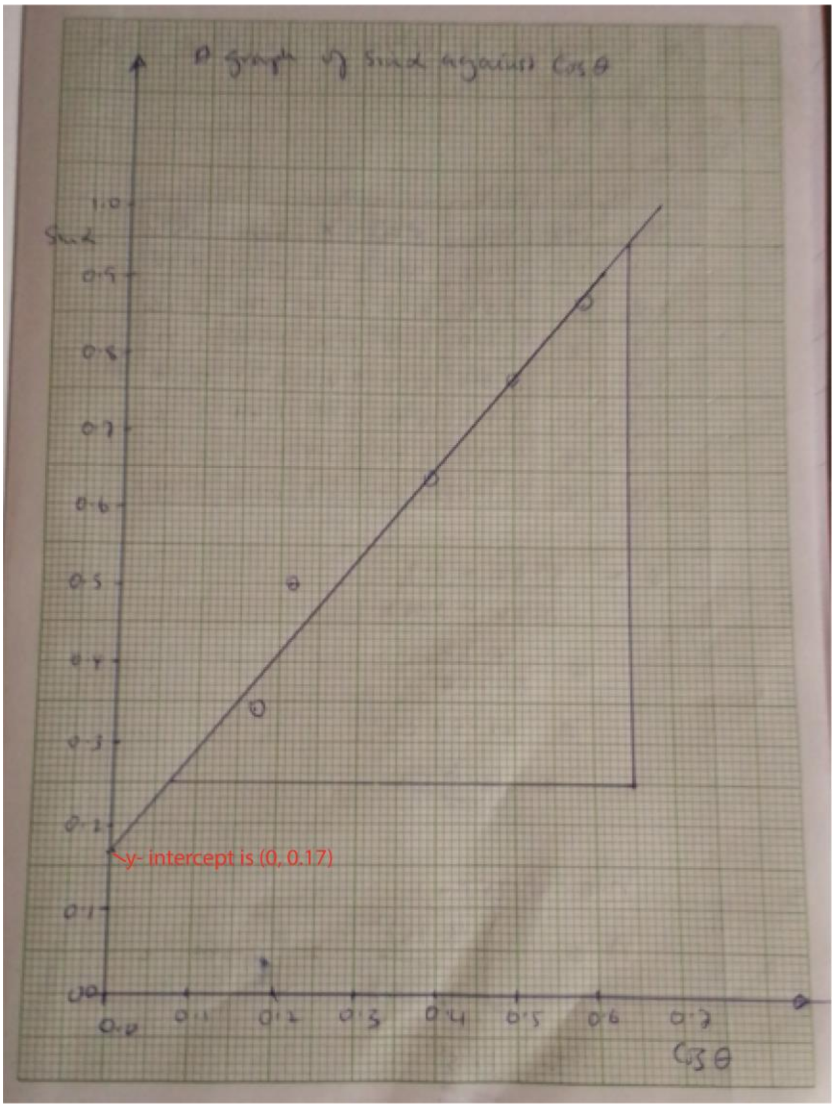
Intercepts

The **y-intercept** is the point where the graphcrosses the y-axis(vertical axis, represented by (0, y).

The **x-intercept** is the point where the graphcrosses the x-axis(vertical axis, represented by (x, 0).

In order to determine the intercepts, the plottng must begin from (0, 0)

Example



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Thanks

Dr. Bbosa Science