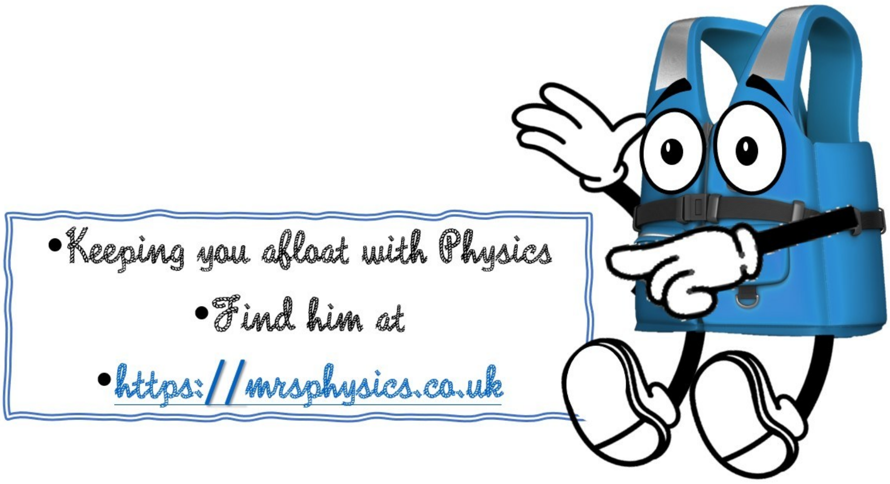


WRITING UP YOUR AH PHYSICS PROJECT

Is not a good title, so make is something like Finding Young's Modulus, SHM, Finding 'g'   Give it a proper title

ABSTRACT

1. It must be either before or after the contents page
2. Brief
3. Give Aims (KISS -keep it simple stupid), if possible find a value
4. Name the experiments (not Expt 1, 2 etc) e.g Finding g by a simple pendulum
5. Add the findings eg Using the simple pendulum g = $9.74 \pm 0.8\ ms^{-2}$
6. CHECK AGAINST the conclusion, lots of candidates transcribe this incorrectly.

If the aim is to measure a physical constant using a number of procedures, candidates should name, or briefly describe, each procedure, stating the value obtained for the constant, complete with unit and preferably the uncertainty, for each procedure.

If the aim is to compare methods, candidates should be clear which aspects are being compared, for example, accuracy, precision, ease of measurement, number of uncertainties, rather than stating 'method A was better than method B'.

If the aim is to confirm a relationship between variables, candidates should be wary of stating that a relationship shows direct proportionality in their findings if the line of best fit does not pass through the origin, unless reference is made to the uncertainty in the y-intercept compared to the y-intercept. [1]

CONTENTS

ABSTRACT

The aim is to determine Young's Modulus of different materials, by different methods. The methods are Bending of an aluminium beam, vibrating wooden beam and stretching a copper wire under gradually increasing tension.

Findings:	Material	Theoretical value for E in GPa	Value of E obtained from the experiment in GPa
Bending Beam	Aluminium	69.0	74.8 ± 4
Vibrating Beam	Wood (Beech)	11.8	10.8 ± 18
wire under increase tension	Copper	117.0	67.3 ± 24

UNDERLYING PHYSICS

Let’s first say what we don’t want!

1. History, socio-economic or other non-physics information it uses up word count
2. N5 or H work unless vital, we assume you know that
3. pages of text
4. stating the relationship without deriving it
5. deriving it without filling in the blanks!
6. AI
7. Direct copies of other people’s work

What we do want

1. demonstrate a good understanding of the physics of your chosen topic.
2. Relevant to their actual experiments
3. derivations or reproducing information from sources where you fill in the missing links between each step.
4. You should, where possible, use referenced diagrams and illustrations in this section.
5. Straight copying from a textbook like Tyler is unlikely to show good understanding, you need to 'fill in the blanks’
6. There ought to be lots of superscripts or numbers in this section where you have used information from at least three sources, and try using a book.
7. Use citation websites to make a reference section.[1], [2], [3] or (Mrsphysics, 2025)

EXPERIMENT 1: GIVE THIS A FULL NAME

AIM

1. State what you want to find in a conclusion
2. If possible give only a one part aim and not several. (eg if you say you're going to find g by 3 different methods and compare you must do both of these things, yet finding g by three different methods will get you one mark for the abstract if you've found 3 values of g and stated which methods).

Make sure that it can't just be answered yes or no.

APPARATUS

1. List of apparatus
2. FULL PAGE, LABELLED PHOTOS WITH NO CLUTTER, use a sheet or paper to cover up your mess, include as much of the equipment as you can.
3. Hand drawn diagrams (use a ruler) and scan if required, (no need to scan but avoids them getting lost)
4. Circuit diagrams if an Electrical project (e.g. LCR circuits)
5. × schematics

PROCEDURE

1. PAST TENSE
2. Measurements and Equipment
3. Increments/ interval of the independent variable.
4. Range and interval of the independent variable.

No need for H&S like Chemistry- it wastes words, and gets no credit.

RESULTS

Show everything!

DATA

1. **<u>All</u> the raw data must be shown, if the candidate has oscillations graphs these must <u>ALL</u> be in an appendix at the back with a sample in the body of the text.**
2. **if they measured the diameter but need the radius, diameter must be shown,**
3. **Put additional data like your** measured constants **in an extra table, eg the Moment of Inertia stuff** diameter, length, breadth, height, angle etc.
4. 5 x 5 is a good minimum for measurements, ie take 5 measurements 5 x each. This is not always enough, for example in curves.
5. **USE EXCEL TO DO THE ANALYSIS (or others)**
6. Paste in sideways or landscape if the paper is too small to view clearly in portrait.

TABLES

1. ALL RAW DATA
2. Decent font size, many of the markers are retired hehehe, and some are actually over 70!
3. Let Excel do the work for you! If your candidates have experience with Excel it can reduce their workload. Why use a calculator when Excel can do it for you? As long as you show a clear example.
4. State whether you are using rounded or unrounded numbers.

GRAPHS

1. In at least 2 out of 3 procedures
2. Full size A4 SIZE LANDSCAPE OR PORTRAIT × Bingo dots

- × google graphs default to 3 or 6 minors to a major!

3. include major and minor gridlines in a colour that prints!!!
4. Paste as an image to easily turn, OR turn the page
5. Perhaps include the need for small data points....no bingo dobbers!
6. Crosses are preferred
7. Put the equations and R^2 value on the graph if using Excel.
8. Start with a font size of 14 point on excel graphs and adjust as necessary
9. Paste graphs as an image or paste directly from excel or add in hand-drawn graphs, add a blank page in the project or run your hand drawn graph through to print page no,it, can be page 38b etc.
10. WHERE POSSIBLE AVOID GOOGLE GRAPHS, PRETTY, BUT PRETTY USELESS

ANALYSIS

1. Show an example of how:-
2. the mean was determined
3. the RU was found
4. The CU and SRU was determined
5. Uncertainties were combined
6. Values were determined and calculated from gradients
7. LINEST values were determined and uncertainties arranged
8. Overall uncertainties were decided.

UNCERTAINTIES

1. **Scale Reading uncertainty, calibration uncertainty and approximate random uncertainty should be given in ALL measurements where possible.**

2. **Combine uncertainties in individual reading and fractionals in different measurements.**

3. Have a table with clear headings and correct units, especially look for units in1/x and x^power
4. For one variable you should show the value of the

   C.U.   S.R.U.   A.R.U.   (ΔCU ΔSU ΔRU)

5. Combine these appropriately - no need for fractional or percentage uncertainties at this stage.
6. For your independent variable you ought to have at least

   C.U.   S.R.U.   (ΔCU ΔSU) and combinations

7. Again give one example of the calculations and state the others were carried out in the same way
8. **Show and use the sum of the square equation**
9. **Look up Calibration (use Norman Fancey and Gemmell Millar) Appendix 2 see reference [10]**
10. **Factional uncertainties in measurements raised to a power should be multiplied by the power before using the sum of the square formula**
11. **Use the LINEST but WITH THE BOX**
12. Show (with sample calculations) how the uncertainties were combined to give the final absolute uncertainty.
13. Clearly state if you are using absolute uncertainty values, fractionals or %.
14. Use LINEST where possible but show the 4 x 4 box at least, or others if the students can use them for their evaluations. Don't write this out, copy and paste it from Excel or alternative. It is best if you explain (at least once) what each section means eg m, Δm, c, Δc
15. Round your final uncertainty to one S.F.

16. **Let EXCEL do the work for the candidates by using the correct formula, but show some calculations.**
17. **Calculations can be done by hand if typing them in takes too long.**
18. **WATCH OUT if you cut and paste (which is a great tool, that you remember to alter the numbers for each experiment's data.**

HINTS

Ctrl + ` (the grave accent key, located above the Tab key) reveals the formulae in Excel

Finding the mean (range is just my document)

=AVERAGE(B3:H3)

Finding the RU in your values

=(MAX(B3:H3)-MIN(B3:H3))/COUNTA(B3:H3)

To square a component

=**cell*cell** *or* **=cell^2**

Calibration Uncertainty (0.5%+ 1 digit)

=(0.005*cell of mean)+0.01

Sum of the squares equation

=SQRT(O3^2+P3^2+Q3^2)

LINEST

=LINEST(range of Y values, range of X values,1,1)

average 3T (s)	a.r.u in 3T	T	$(T)^2$	Period $(T)^2$	a.r.u in 3T	Scale reading uncertainty in 3T	calibration uncertainty in 3T	combining uncertainty in T	fractional uncertainty in T	Fractional Uncertainty in T^2	absolute uncertainty in T^2	Scale reading uncertainty in l	calibration uncertainty in l	combining absolute uncertainty in l
(av)	(s)	(s)	(s^2)	(s^2)	(s)	(s)	(s)	(s)			(s^2)	(m)	(m)	(m)
=AVERAGE(B3:H3)	=(MAX($B3:$H3)-MIN($B3:$H3))/COUNTA($B3:$H3)	=I3/3	=K3*K3	=K3^2	=(MAX(B3:	0.02	=0.5/100*I3+0.01	=SQRT(O3^2+P3^2+Q3^2)	=R3/I3	=2*S3	=T3*L3	0.001	0.0005	=SQRT(V3^2+W3^2)
=AVERAGE(B4:H4)	=(MAX($B4:$H4)-MIN($B4:$H4))/COUNTA($B4:$H4)	=I4/3	=K4*K4	=K4^2	=(MAX(B4:	0.02	=0.5/100*I4+0.01	=SQRT(O4^2+P4^2+Q4^2)	=R4/I4	=2*S4	=T4*L4	0.001	0.0005	=SQRT(V4^2+W4^2)
=AVERAGE(B5:H5)	=(MAX($B5:$H5)-MIN($B5:$H5))/COUNTA($B5:$H5)	=I5/3	=K5*K5	=K5^2	=(MAX(B5:	0.02	=0.5/100*I5+0.01	=SQRT(O5^2+P5^2+Q5^2)	=R5/I5	=2*S5	=T5*L5	0.001	0.0005	=SQRT(V5^2+W5^2)
=AVERAGE(B6:H6)	=(MAX($B6:$H6)-MIN($B6:$H6))/COUNTA($B6:$H6)	=I6/3	=K6*K6	=K6^2	=(MAX(B6:	0.02	=0.5/100*I6+0.01	=SQRT(O6^2+P6^2+Q6^2)	=R6/I6	=2*S6	=T6*L6	0.001	0.0005	=SQRT(V6^2+W6^2)
=AVERAGE(B7:H7)	=(MAX($B7:$H7)-MIN($B7:$H7))/COUNTA($B7:$H7)	=I7/3	=K7*K7	=K7^2	=(MAX(B7:	0.02	=0.5/100*I7+0.01	=SQRT(O7^2+P7^2+Q7^2)	=R7/I7	=2*S7	=T7*L7	0.001	0.0005	=SQRT(V7^2+W7^2)
=AVERAGE(B8:H8)	=(MAX($B8:$H8)-MIN($B8:$H8))/COUNTA($B8:$H8)	=I8/3	=K8*K8	=K8^2	=(MAX(B8:	0.02	=0.5/100*I8+0.01	=SQRT(O8^2+P8^2+Q8^2)	=R8/I8	=2*S8	=T8*L8	0.001	0.0005	=SQRT(V8^2+W8^2)
=AVERAGE(B9:H9)	=(MAX($B9:$H9)-MIN($B9:$H9))/COUNTA($B9:$H9)	=I9/3	=K9*K9	=K9^2	=(MAX(B9:	0.02	=0.5/100*I9+0.01	=SQRT(O9^2+P9^2+Q9^2)	=R9/I9	=2*S9	=T9*L9	0.001	0.0005	=SQRT(V9^2+W9^2)
=AVERAGE(B10:H10)	=(MAX($B10:$H10)-MIN($B10:$H10))/COUNTA($B10:$H10)	=I10/3	=K10*K10	=K10^2	=(MAX(B10	0.02	=0.5/100*I10+0.01	=SQRT(O10^2+P10^2+Q10^2)	=R10/I10	=2*S10	=T10*L10	0.001	0.0005	=SQRT(V10^2+W10^2)
=AVERAGE(B11:H11)	=(MAX($B11:$H11)-MIN($B11:$H11))/COUNTA($B11:$H11)	=I11/3	=K11*K11	=K11^2	=(MAX(B11	0.02	=0.5/100*I11+0.01	=SQRT(O11^2+P11^2+Q11^2)	=R11/I11	=2*S11	=T11*L11	0.001	0.0005	=SQRT(V11^2+W11^2)
=AVERAGE(B12:H12)	=(MAX($B12:$H12)-MIN($B12:$H12))/COUNTA($B12:$H12)	=I12/3	=K12*K12	=K12^2	=(MAX(B12	0.02	=0.5/100*I12+0.01	=SQRT(O12^2+P12^2+Q12^2)	=R12/I12	=2*S12	=T12*L12	0.001	0.0005	=SQRT(V12^2+W12^2)

CONCLUSION

1. Make sure this matches your data
2. Don't say it is directly proportional unless it goes through the origin
3. Say there is a linear trend
4. Don't make obvious curves into straight lines
5. If your value for Young's Modulus, E is factors out, then check your units
6. Include a final uncertainty where possible.
7. Keep it brief but make sure it answers your aim (you can always change the aim before printing the final version!)

EVALUATION

1. This can be in the first person.
2. Base the evaluations on your uncertainties
3. There ought to be numbers in your evaluations!
4. If you've found a value do your uncertainties include the true value if not why?
5. What was the largest uncertainty? How can this be reduced?
6. Was the range adequate?
7. Were there any rogue points?
8. Then follow the list in the MI
9. the accuracy and precision of their measurements;
10. the adequacy of repeated readings;
11. the adequacy of the range over which variables are altered;
12. the adequacy of control of variables;
13. any limitations of their equipment;
14. the reliability of their methods;
15. and on sources of uncertainties.

OVERALL EVALUATION

1. write this section up as you go through the practical work, use bullet points, and work up later.
2. Let the class know how many students want the same kit (but this ought to have been sorted in the planning stage)
3. the reasons for selection of procedures;
4. problems encountered during planning;
5. modifications <u>to planned </u>procedures;
6. interpretation and significance of findings;
7. suggestions for further improvements; and
8. suggestions for further work.

EXPERIMENT 2. THE WAY TO DO EACH SECTION

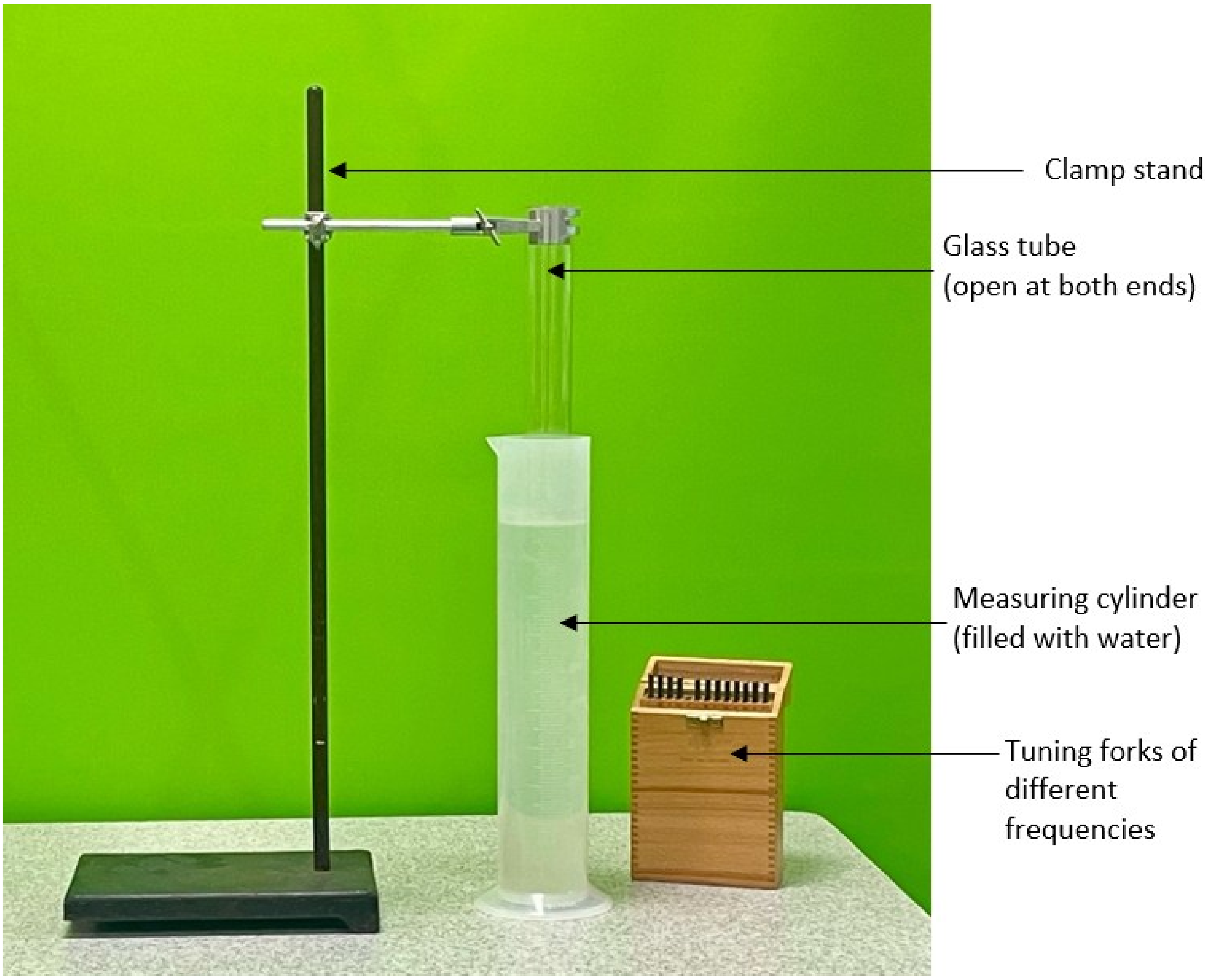
Some good examples in this section, taken from my students' projects or made up. Obviously I've taken these examples from different experiments

AIM

To find a value for Youngs Modulus of a Steel Wire using a stretched string.

PROCEDURE

I'd say this is a perfect diagram! Not good for H&S though



PROCEDURE

This is the type of thing they're looking for,

A thin piece of thread was clamped between two 2-pence coins and clamped into a clamp on a clamp stand. 150 cm of thread was cut and allowed to hang. A small piece of blu-tak was added to form a bob. The length of the thread between the pivot and the centre of the bob was measured using a steel tape measure. The bob was released to an angle of 10 degrees and released The stopwatch was started when the bob reached the equilibrium position and the time for 10 oscillations was recorded. The thread was shortened by pulling up the thread between the two 2-pence coins and the new length measured. 5 repeats were completed for each length of string and the length was altered between 0.70 m and 1.45 m in 0.15 increments.

RESULTS

The table on the next page has all the data, repeats, correct units. All the numbers are to the correct and consistent sig fig. As it is copied directly from Excel I was able to edit out a rogue column.

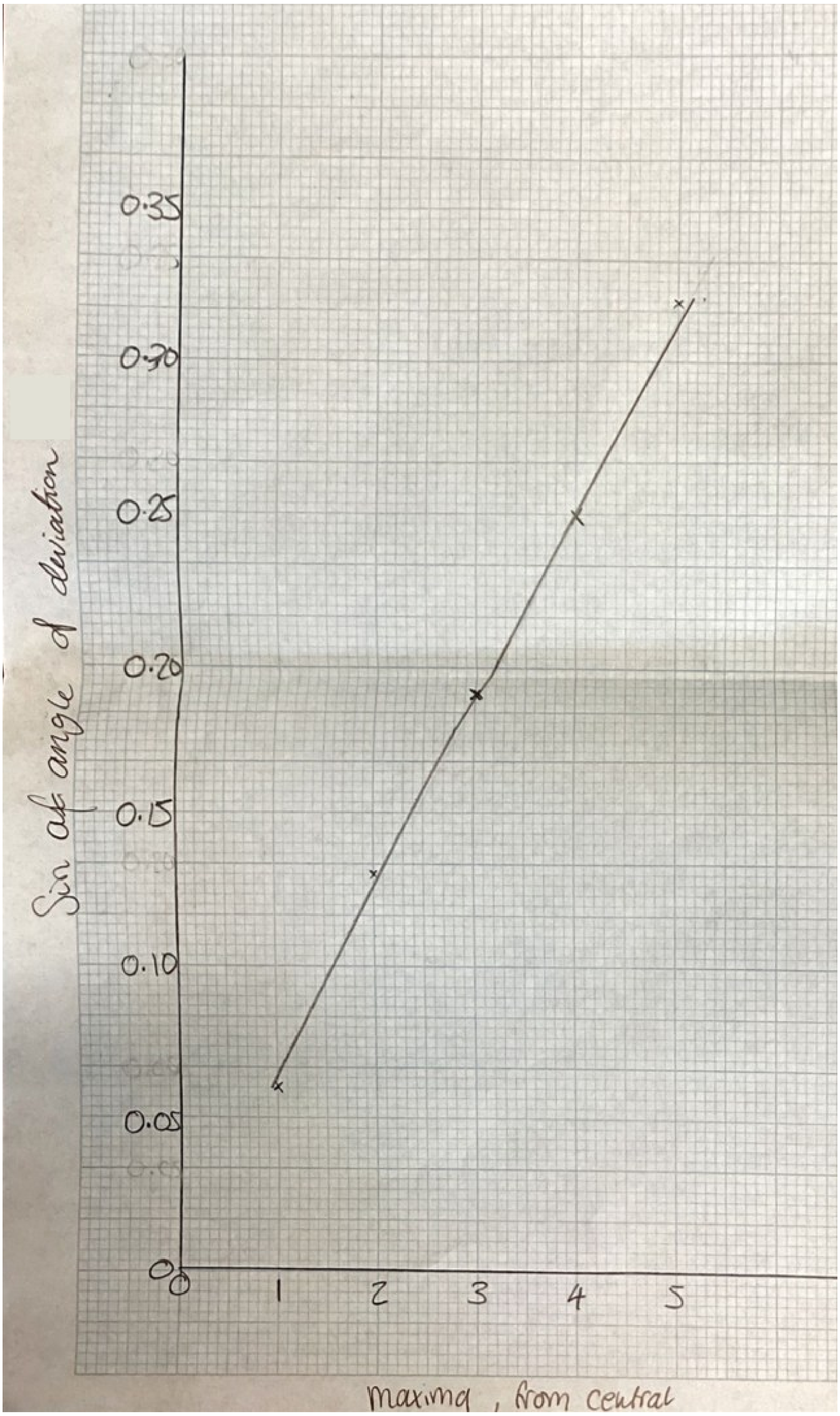
RAW DATA

Musical note	Frequency (Hz)	1/Frequency (s)	Length (m)											2L=Wavelength (m)
			1	2	3	4	5	6	7	8	9	10	Average	
C	512.0	0.00195	0.29	0.35	0.31	0.34	0.32	0.36	0.30	0.33	0.34	0.31	0.33	0.65
B	480.0	0.00208	0.34	0.37	0.33	0.38	0.35	0.36	0.34	0.37	0.38	0.33	0.36	0.71
A#	456.0	0.00219	0.36	0.39	0.37	0.35	0.38	0.36	0.40	0.38	0.37	0.35	0.37	0.74
A	426.6	0.00234	0.39	0.43	0.38	0.42	0.41	0.40	0.44	0.42	0.40	0.39	0.41	0.82
G#	406.4	0.00246	0.40	0.44	0.41	0.45	0.43	0.42	0.40	0.43	0.45	0.41	0.42	0.85
G	384.0	0.00260	0.44	0.48	0.43	0.46	0.45	0.44	0.47	0.46	0.48	0.45	0.46	0.91
F#	362.0	0.00276	0.46	0.50	0.45	0.49	0.48	0.47	0.50	0.48	0.49	0.46	0.48	0.96
F	341.3	0.00293	0.48	0.52	0.49	0.51	0.50	0.49	0.53	0.50	0.52	0.48	0.50	1.00
D#	304.4	0.00329	0.54	0.58	0.53	0.57	0.56	0.55	0.58	0.56	0.57	0.54	0.56	1.12
D	288.0	0.00347	0.58	0.63	0.59	0.61	0.60	0.62	0.59	0.61	0.63	0.58	0.60	1.21
C#	271.2	0.00369	0.61	0.67	0.63	0.65	0.64	0.66	0.62	0.65	0.67	0.61	0.64	1.28
C	256.0	0.00391	0.65	0.70	0.66	0.69	0.68	0.67	0.71	0.68	0.70	0.66	0.68	1.36

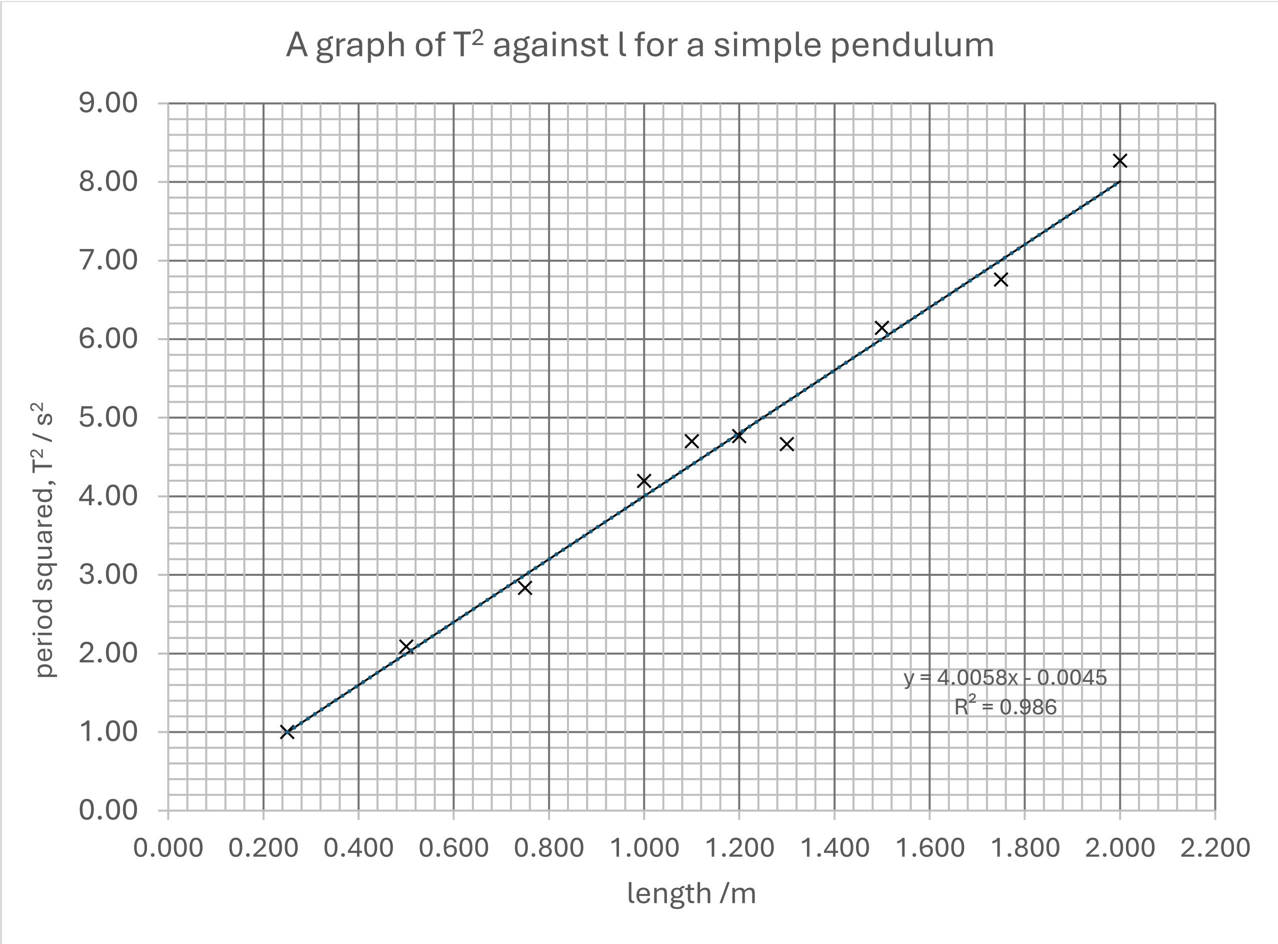
Mass added on the beam	Masses added on the beam	Deflection of the beam (mm)						Average deflection	Average deflection
g	kg	1	2	3	4	5	6	mm	m
90.187	0.090187	2.15	2.32	2.35	2.59	2.11	2.26	2.30	0.002297
100.165	0.100165	2.25	2.5	2.56	2.96	2.41	2.46	2.52	0.002523
110.205	0.110205	2.65	2.76	3.27	3.17	2.58	2.64	2.85	0.002845
120.125	0.120125	2.7	3.2	3.49	3.45	2.82	2.89	3.09	0.003092
130.049	0.130049	3.17	3.41	3.9	3.67	3.02	3.14	3.39	0.003385
140.003	0.140003	3.68	3.59	3.62	3.82	3.42	3.39	3.59	0.003587

This table was copied as a graphic. It makes turning it so much easier, but usually doesn't print as clearly but it can be enlarged.

Breadth of beam, b	Depth of beam, d	Length of beam, L
m	m	m
0.02	0.003	0.76

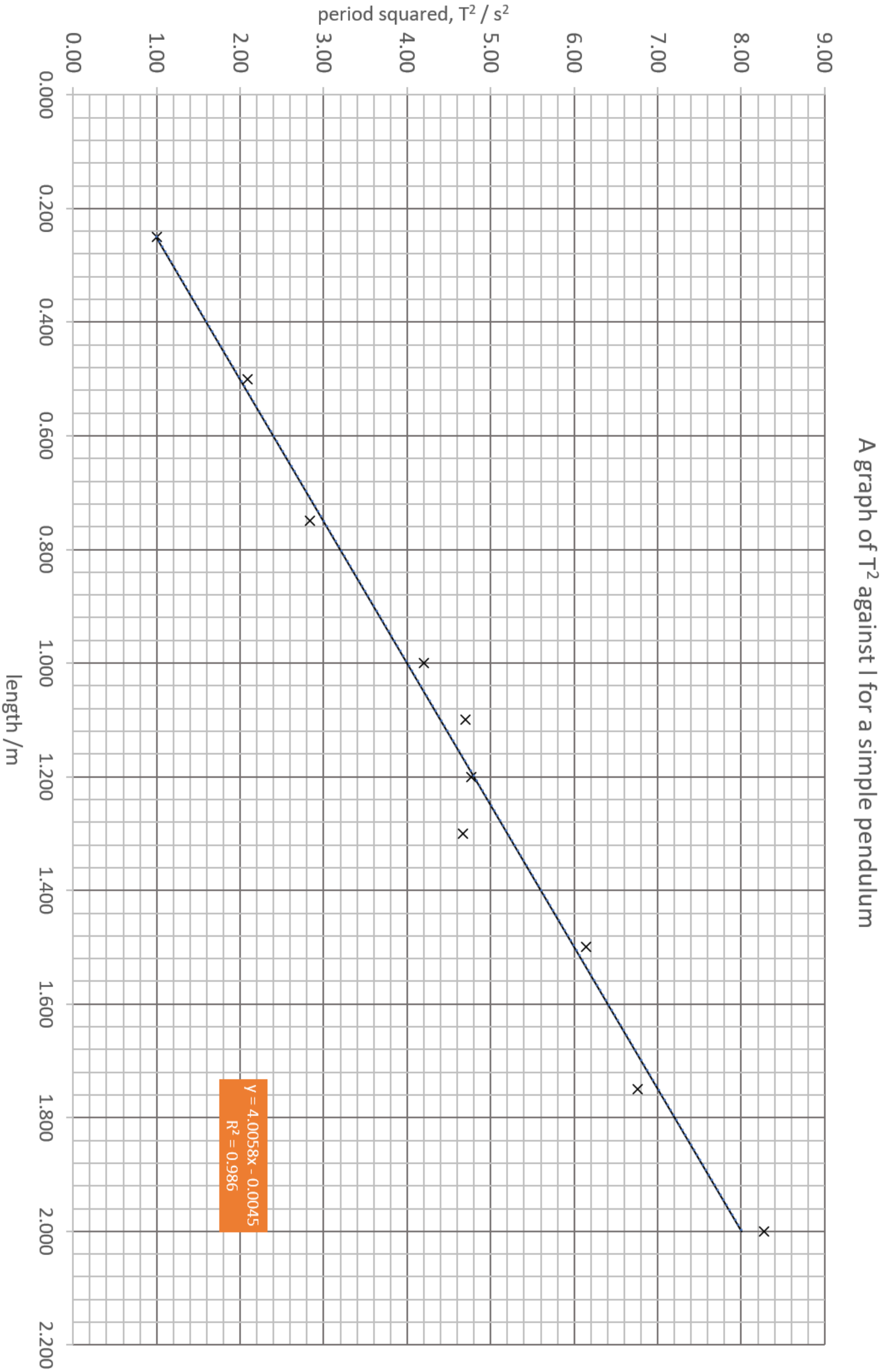


Not a great scan, I'd probably just include the original. Better to teach Excel lower in the school. Leave a blank page when printing out the project and slip in your hand drawn graph, or put that through the printer if you want the page number to print out



The example on this page is pasted directly from excel. The beauty of this is you can edit it and check the data, It is pretty clear. Make sure when you paste it the crosses and writing don't become huge. Just use 12 point in excel and it should print out fine. Don't forget to make sure the axes are to the same sig fig, eg 0.80, 0.90, **1**, *1.1, 1.2 etc this is the default setting. I've seen some lovely graphs with nice blue minor gridlines, like graph paper that show up well.*

The example on the next page is the same graph but copied as a graphic. It is so easy to rotate and fill up a whole page but there is no editing facility.


A graph of T2 against l for a simple pendulum
period squared, T2 / s2
length /m
y = 4.0058x - 0.0045
R2 = 0.986
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
0.000
0.200
0.400
0.600
0.800
1.000
1.200
1.400
1.600
1.800
2.000
2.200

a.r.u in 3T	Scale reading uncertainty in 3T	calibration uncertainty in 3T	combining uncertainty in 3T	fractional uncertainty in T	Fractional Uncertainty in T^2	absolute uncertainty in T^2	Scale reading uncertainty in l	calibration uncertainty in l	combining absolute uncertainty in l
(s)	(s)	(s)	(s)			(s^2)	(m)	(m)	(m)
0.02	0.02	0.0250	0.039	0.013	0.026	0.026	0.001	0.0005	0.0011
0.24	0.02	0.0317	0.246	0.057	0.113	0.237	0.001	0.0005	0.0011

$mean = \frac{\sum x}{n}$	$\Delta R = \frac{R_{max} - R_{min}}{n}$	**Calibration** **±0.5% + 1 digit**	**Combining in T**
$mean = \frac{3.26 + 4.36 + 4.96 + 4.34 + 4.46 + 4.38 + 4.59}{7}$	$\Delta R = \frac{4.96 - 3.26}{7}$	$\frac{0.5}{100} \times 4.34 + 0.01$ =0.0317	$\Delta T = \sqrt{0.24^2 + 0.02^2 + 0.0317^2}$ ΔT =0.24 Showing for rule of 3 0.24 is 3x greater ∴ overall ΔT Simplify on the rule of 3
Uncertainty in T^2 As T is raised to the power 2 then the uncertainty in T^2 is $2\left(\frac{\Delta T}{T}\right)$	ΔT =0.246 $\frac{\Delta T}{T} = \frac{0.246}{4.34} = 0.0567$	uncertainty in T^2 is $2\left(\frac{\Delta T}{T}\right)$=2×0.0567=0.113 Or 11.3%	Absolute uncertainty in T^2 $2\left(\frac{\Delta T}{T}\right) \times T^2 = 0.113 \times 2.09 =$ 0.236 or 11.3% of value of T^2

Scale Reading Uncertainty= increasing to 0.02 s for reaction time.
Scale reading uncertainty in length maybe doubled as you can't identify exactly the centre of mass.
Now uncertainty in $T^2$and l can be used for error bars in the graph.

For example the uncertainty in the length is

$$\sqrt{(SRU)^2 + (ARU)^2 + (CU)^2}$$

By the rule of three the calibration uncertainty can be ignored.

$$\sqrt{(0.001)^2 + (0.001)^2}$$

CONCLUSION

From my results I determined the value of g to be
9.46 ± 0.8 ms^{-2}

EVALUATION

My result show a value of 9.46 ± 0.8 ms^{-2}

This is in the range of 8.66 -10.26 ms^{-2}. This includes the expected value of 9.8 ms^{-2}. Although this uncertainty includes the theoretical value I have an 8% uncertainty which is quite high for this experiment. Looking at my results there was a high random uncertainty in one of my points and I ought to have rejected this point and remeasured it. Taking out this point from my data, reduced the random uncertainty in 10T from 0.12 to 0.05…..

or

Percentage difference in calculated speed of sound:

$$\text{Percentage difference in calculated speed of sound} = \left(\frac{|v_{calculated} - v_{actual}|}{v_{actual}}\right) \times 100$$

Percentage difference in calculated speed of sound

$$= \left(\frac{|355.6 - 342.55|}{342.55} \right) \times 100 = 3.8\%$$

There is a 3.8% difference between the calculated speed of sound and accepted theoretical value of ±342.55 m s^{-1} at 19°C, [reference this] and the calculated speed of sound value does not lie within the accepted theoretical value. This indicated that the calculated speed of sound in air is not accurate, and that there may be systematic errors in the setup or measurements. The largest uncertainty in my calculations was the calibration uncertainty in the frequency. I could have reduced this by doing *x* and *y*. The random uncertainty in my values of λ was very low suggesting a low precision instrument or high precision in measuring. The closeness to the true value suggests that precision was good.

The results showed a clear trend that as the frequency of the tuning fork increases, the measured resonance length decreases, which is consistent with the expected inverse relationship between frequency and wavelength $v = f\lambda$.

I did not take account of the end correction in the length of the tube and this could have introduced a systematic uncertainty.

EVALUATION:

My project yielded three values for the measurement of the moment of inertia but each was successful in different ways. Method 1 had good accuracy, but poor precision (add in numbers) Method 2 was 3 orders of magnitude greater than my expected value and I really ought to have noticed that I couldn't convert between mm, cm and m. I ought to have spotted this at an earlier stage so that I didn't lose marks in the complexity section. Method 3 showed high precision and reasonable accuracy, but this procedure took about 6 hours to get my results as the equipment wasn't available, the travelling microscope needed to be cleaned as I couldn't work out why I couldn't read the vernier. It was fiddly to do, and I had to check it each time I came to use it as it was left in a classroom where other students kept looking at it and moving it.

I was unable to work out the material used to produce my metre stick, so I am unable to precisely say if my method is close to the theoretical value, but from catalogues I determined most metre sticks are made of XXX wood.

If I was to complete the project again, I would try to use the same material for all three experiments and ensure that the three procedures all fitted the material I had, It would then be easier to do a comparison.

As there are 44 candidates in my school all wanting the same equipment, I had planned to do the bifilar pendulum to find g but this project was taken and the class didn't sit down and make a table of who wanted what equipment and when it was available etc.

Further adjustment are not to copy this down any of this evaluation by students as some of this is tongue in cheek. A good evaluation should make the marker feel your frustration or delight on how the project went.

EXPERIMENT 3- WHAT NOT TO DO

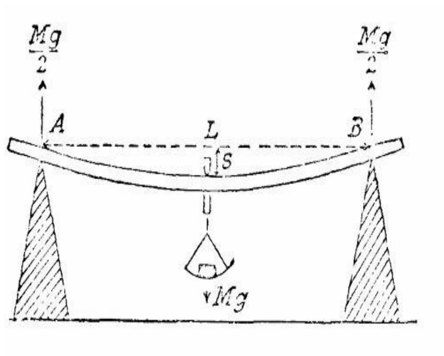
Some examples of some things not to write

AIM

The aim of my experiment is to determine a value for the gravitational field strength using a compound pendulum and compare it to the value obtained from the other experiments and see which is the most accurate and precise.

PROCEDURE

I set the apparatus up as shown below. The beam was placed on knife edges, which are made of razor blades, and thnn I put a piece of rope around the middle and added a mass hanger. I did this 3x.



RESULTS

The table shows the results for 1/f against Xc. The Xc values were calculated from the values of V and the corresponding values of I.

Av 1/f	**Av Xc**
s	**(Ω)**
0.01	148.58
0.005	77.36

0.003333	51.936
0.0025	41.11
0.002	32.75

Inconsistent sig fig, not raw data. This table doesn't show the raw data and it splits across a page (sort this out in word)

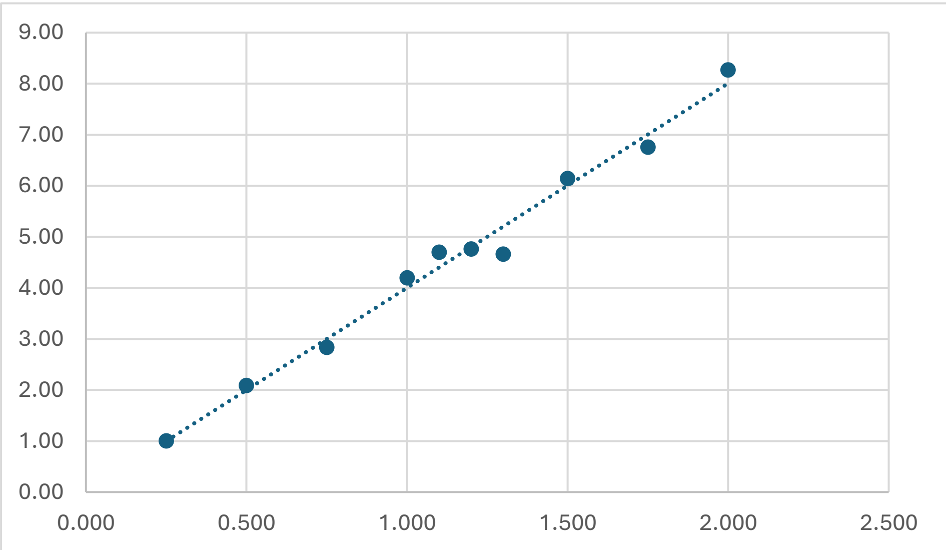
RESULTS

Table far too small

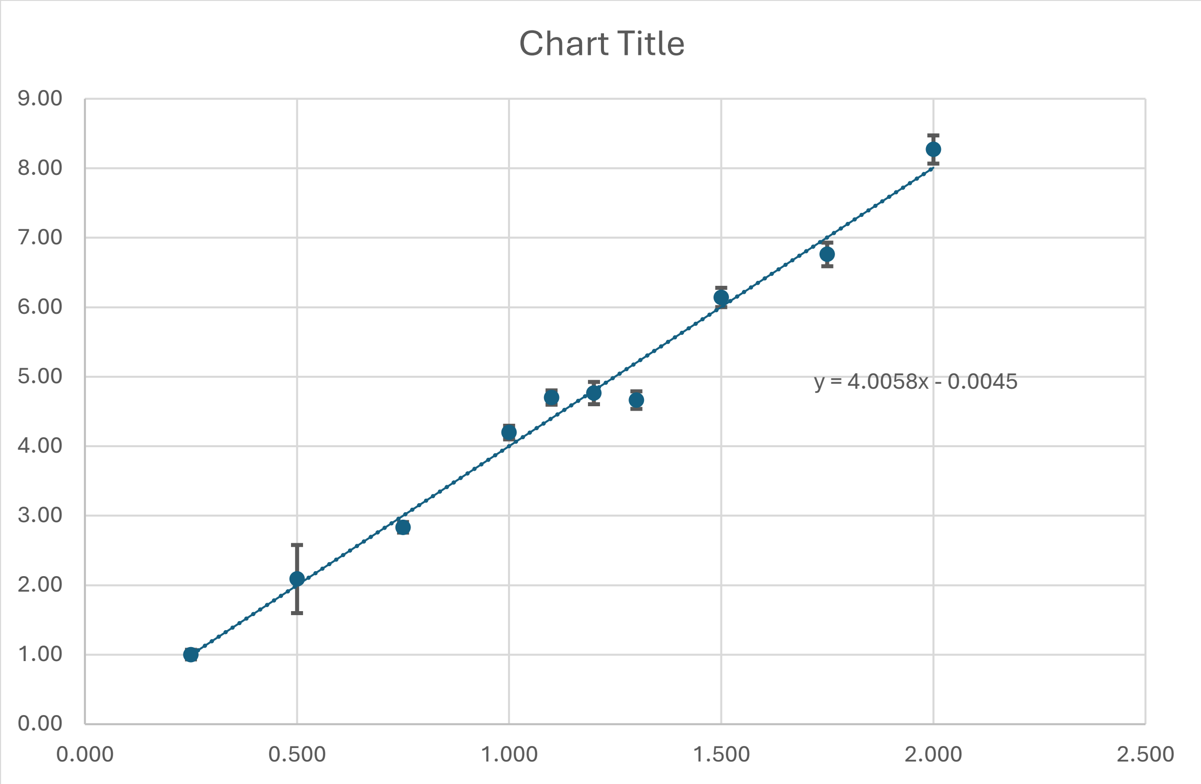
length of thread	Time for three swings (s)							average 3T (s)	T	$(T)^2$	g
m	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(av)	(s)	(s^2)	(ms^{-2})
0.250	3.04	2.99	2.93	3.08	2.99	2.99	3.00	3.00	1.00	1.00	9.85
0.500	3.26	4.36	4.96	4.34	4.46	4.38	4.59	4.34	1.45	2.09	9.45
0.750	4.99	5.06	5.06	5.06	5.06	5.06	5.06	5.05	1.68	2.83	10.45
1.000	6.24	6.22	6.08	6.06	6.18	6.10	6.14	6.15	2.05	4.20	9.41
1.100	6.59	6.40	6.55	6.47	6.47	6.51	6.54	6.50	2.17	4.70	9.24
1.200	6.39	6.68	6.56	6.44	6.86	6.45	6.46	6.55	2.18	4.76	9.94
1.300	6.32	6.38	6.40	6.64	6.59	6.63	6.39	6.48	2.16	4.66	11.00
1.500	7.45	7.62	7.32	7.31	7.55	7.52	7.27	7.43	2.48	6.14	9.64
1.750	7.93	7.93	8.11	7.63	7.63	7.68	7.69	7.80	2.60	6.76	10.22
2.000	9.01	8.59	8.55	8.41	8.41	8.60	8.82	8.63	2.88	8.27	9.55
											9.88

length of thread	a.r.u in 3T	Scale reading uncertainty in 3T	calibration uncertainty in 3T	combining uncertainty in 3T	fractional uncertainty in T	Fractional Uncertainty in T^2	absolute uncertainty in T^2	Scale reading uncertainty in l	calibration uncertainty in l	combining absolute uncertainty in l
m	(s)	(s)	(s)	(s)			(s^2)	(m)	(m)	(m)
0.250	0.02	0.02	0.0250	0.039	0.013	0.026	0.026	0.001	5E-04	0.0011
0.500	0.24	0.02	0.0317	0.246	0.057	0.113	0.237	0.001	5E-04	0.0011
0.750	0.01	0.02	0.0353	0.042	0.008	0.017	0.047	0.001	5E-04	0.0011
1.000	0.03	0.02	0.0407	0.052	0.008	0.017	0.071	0.001	5E-04	0.0011
1.100	0.03	0.02	0.0425	0.054	0.008	0.017	0.078	0.001	5E-04	0.0011
1.200	0.07	0.02	0.0427	0.082	0.013	0.025	0.119	0.001	5E-04	0.0011
1.300	0.05	0.02	0.0424	0.065	0.010	0.020	0.094	0.001	5E-04	0.0011
1.500	0.05	0.02	0.0472	0.072	0.010	0.019	0.118	0.001	5E-04	0.0011
1.750	0.07	0.02	0.0490	0.087	0.011	0.022	0.150	0.001	5E-04	0.0011
2.000	0.09	0.02	0.0531	0.103	0.012	0.024	0.197	0.001	5E-04	0.0011

GRAPH



This graph has no labels, has a dotted line and bingo dots. There are no minor gridlines. The equation is not given on the graph or the R^2 value (not required but helpful to most markers, especially in this age of made-up answers)



Honestly for the extra time error bars are not worth it and if you put them in, every point has to have the correct error bars (individually done through your overall uncertainty in your x and y value. Don't put your students through that.

UNCERTAINTIES

I couldn't find a calibration uncertainty and didn't bother to look in the guide.

My scale reading uncertainty was 20 and this is three times bigger than all the others so it is dominant so my overall uncertainty if ± 0.6 GPa which I found from LINEST, withouth showing you the data in the 4 box table.

CONCLUSION

G is 9.8 ms-2

EVALUATION

My results were accurate and my results were precise not because I've really looked at them but because I know these terms from higher and I know what I am meant to say from Higher, instead of realising that I totally need to raise my game here and come up with something more than I couldn't repeat the experiment more than three times as I didn't have time and I never thought it might take me more than 35 mins to set up the kit take the readings and put it away.

I wont have realised that all one sets of measurements should be taken and then the whole experiment is repeated as it is much easier to swing a pendulum 5 times from one length and then move on to the next length not realising that the temperature has increased in the classroom by 5 degrees Celsius during that time due to all the hot air. I think there are ways you can say that the school is mince with tattie equipment and no technician support without looking like you are blaming everyone else but yourself.

My further work shouldn't be about more repeats and more range if I have a perfectly straight line with all the points on the line and I wouldn't think to look at the uncertainties and see which is the biggest. If I did that, I'd probably know what I was doing so I could do a good evaluation.

I will probably be trying to write this in some highfaluting Physics speak so it makes me look more scientific; when I sound like I haven't understood what I was doing. This section shouldn't also show that I didn't do any planning b

ut that I just turned up on three separate double periods and followed a preprinted sheet and didn't take all the measurements I needed and didn't really know what I was doing.

OVERALL EVALUATION

Don't run your work through AI like I've just done here. This is what AI did to my previous evaluation,

our evaluation reads like someone who has discovered the sacred Higher Physics phrases "accurate" and "precise" and decided that simply chanting them is equivalent to doing an actual scientific analysis. The results were apparently both accurate and precise, not because any meaningful consideration of uncertainty or systematic error was carried out, but because those are the magic words expected in a report. Scientific method by horoscope.

The practical procedure itself appears to have been based on the ambitious assumption that all apparatus would instantaneously materialise, function correctly, and then politely tidy itself away within 35 minutes. Consequently, the experiment was repeated only three times, less as a statistically justified choice and more because the clock became an unavoidable force of nature. Planning seems to have consisted primarily of optimism.

There is also the subtle issue that all measurements for one pendulum length were taken consecutively before moving to the next, which is wonderfully efficient if the laws of thermodynamics have agreed to take the afternoon off. Unfortunately, the classroom temperature apparently increased by around 5°C during the experiment due to the industrial quantity of hot air circulating the room. Any resulting systematic drift in measurements was ignored in favour of convenience because repeatedly adjusting the pendulum length is mildly irritating.

The equipment itself possessed all the precision engineering qualities of damp tatties in a Tesco carrier bag. However, blaming the apparatus entirely would be unfair, as this would imply there had been enough experimental awareness to recognise the limitations at the time. A more balanced conclusion is that the low-quality equipment and absence of technician support increased uncertainty, while the experimental method simultaneously did absolutely nothing to compensate for this.

The “further work” section also risks becoming a ceremonial exercise in writing “more repeats” and “greater range” despite already producing a graph so suspiciously straight that it resembles a GCSE textbook example rather than real data. A genuinely useful evaluation would identify the dominant uncertainty, estimate its effect on the gradient, and suggest improvements targeted specifically at reducing that uncertainty. Unfortunately, doing that would require actually understanding the experiment rather than aggressively paraphrasing a marking scheme.

Most impressive of all is the instinct to disguise confusion beneath layers of high-falutin scientific vocabulary. This creates the remarkable effect of sounding simultaneously overconfident and deeply uncertain, like a lab report written by a thesaurus having a panic attack. The evaluation should not unintentionally reveal that the practical consisted largely of arriving across three double periods, following a pre-printed instruction sheet with the emotional investment of assembling flat-pack furniture, and only realising afterwards that several essential measurements were never actually taken.

In summary, the investigation demonstrates a strong commitment to the appearance of scientific rigour, while the actual rigour itself appears to have been absent on annual leave.

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NB 4 and 5 are one reference, even if you add in different editions

APPENDICES