IOP Scotland

AH Physics
Writing up project reports

Wednesday, 27 May 2026

1

Have you read the document?

Advanced Higher Coursework Assessment Task

SQA

Advanced Higher Physics
Project
Assessment task

Valid from session 2019-20 and until further notice.

https://www.sqa.org.uk/files_ccc/AHCATPhysics.pdf

........and have your students?

SQA

Course report 2025

Advanced Higher Physics

........and I wish more of you read these

This report provides information on candidates' performance. Teachers, lecturers

Project

The project performed as expected.

In some cases, it was evident that lack of exposure to appropriate practical work throughout the course might have had an impact on the ability of some candidates to undertake an appropriate project successfully.

2

PLANNING IS KEY TO A STUDENT'S SUCCESS

Where possible get students typing their results straight into Excel to locate those mistakes (use for H and N5 too)

3

PLANNING IS KEY TO A STUDENT'S SUCCESS

PLEASE WORK WITH YOUR STUDENTS ON THE PLANNING PHASE

4

Planning

To score well in the project, each candidate should be encouraged to choose a topic for which the underlying physics and experimental procedures present an appropriate level of challenge, and facilitates the opportunity to access marks for the introduction, procedures, results, and discussion. In particular, the experimental procedures should allow graphical analysis to be carried out and it should be commensurate with Advanced Higher level. Topics should involve 10 to 15 hours of experimental work for the candidate.

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Planning

Choosing the topic

At the start of the research stage, the teacher or lecturer must agree the choice of topic with the candidate to ensure that it:

- is appropriate for Advanced Higher Physics
- has associated experimental work that can generate numerical data suitable for graphical analysis
- allows the candidate the opportunity to access all of the available marks

Unless a centre is presenting a large number of candidates (more than 10), the teacher or lecturer must not allow a candidate to choose a topic that may lead to experimental procedures similar to those being carried out by another candidate in the centre.

Centres presenting a larger number of candidates must minimise the number of candidates investigating the same topic. If two candidates in a centre are following the same experimental procedures, the teacher or lecturer must ensure that each candidate carries out research, including experimental work, individually.

There should be no need for candidates in a small presentation group to be investigating topics leading to similar experimental procedures.

Once candidates have agreed the topic with their teacher or lecturer, they must formulate an aim.

Version 1.0 5

.....the key for students

- Do the students really know what they're doing before they start? (many don't)
- Plan before you start the project
- Do students have 3 expts?
- Can they generate three graphs at least 2?
- Will it be 10-15 hours work?

6

Preparing Candidates

.....unless centres are presenting a large number of candidates (> 10), candidates should not be allowed to choose a topic that may lead to experimental procedures similar to those being carried out by another candidate in the centre.
larger presenting centres must minimise the number of candidates investigating the same topic and have at least ten different topics available.
<10 candidates should not be investigating the same topic.
if two candidates in a centre are following the same experimental procedures, the teacher or lecturer must ensure that each candidate carries out research, including experimental work, individually, and group work is not allowed.

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No excuse not to get the following marks

Section	Max mark	Expected response and marking instructions
6 Presentation (2 marks)		
6 a	1	**A report with an appropriate structure, including informative title, contents page and page numbers.** • The project report structure must be easy to follow. • An informative title and contents page are essential. The contents page must show the sections within the report along with their corresponding page numbers and the pages throughout the report must be numbered. Do not penalise occasional missing page numbers, for example on graph pages.
6 b	1	**References to at least three sources cited in the text and listed at an appropriate point in the report. Citing and listing must use either Vancouver or Harvard systems.** • The references must be: — relevant to the aim of the project — cited within the project report — listed at or near the end of the project report — in either Vancouver or Harvard referencing systems • To be acceptable: — Internet sources must be referenced by as many of the following as possible: author(s) (year), article title, website title, full URL, date of access. — Book sources must be referenced by as many of the following as possible: author(s) or editor(s), title of book, edition number (if other than first edition), place (city) of publication, publisher's name, year of publication, page numbers. — Journal sources must be referenced by as many of the following as possible: author(s), year of publication, title of journal article, title of journal, volume number, issue number, page numbers of the article. Ignore additional references cited or listed incorrectly.

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Presentation- References

References to at least three sources of information, listed at the end of the report, should also be cited in the report where information is quoted from the sources. Both the listing and citing of references should use either Vancouver or Harvard referencing. In addition to support in the 'Instructions for candidates' section, many internet sites offer guidance and support in referencing in Vancouver or Harvard style.

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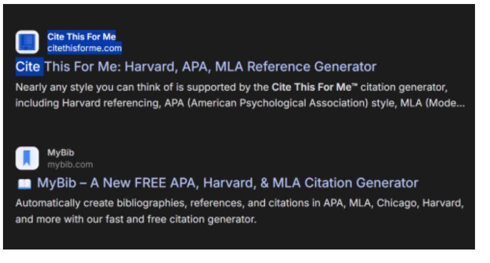
Use an online reference generator



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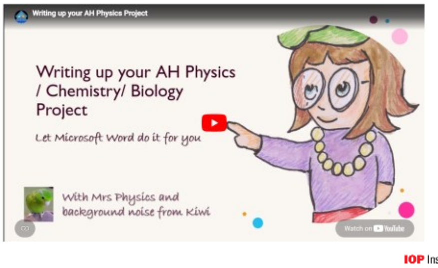
No templates, but you can teach them



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Abstract

Candidates should state a clear overall aim(s) for their project and state findings clearly. 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.

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Abstract

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

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Underlying physics

Underlying physics To score well in this section, candidates should demonstrate a good understanding of the physics of their chosen topic. Simply stating a number of relationships without any derivation or reproducing information from sources without input from the candidate, would not demonstrate a good understanding. Candidates should be encouraged to use referenced diagrams and illustrations in this section. The inclusion of historical, socio-economic or other non-physics information may be of interest but does not contribute towards demonstrating an understanding of physics and is not given credit.

Perhaps include that straight copying from a textbook like Tyler is unlikely to show good understanding. They need to 'fill in the blanks'.

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Underlying Physics

1. demonstrate a good understanding of the physics of their chosen topic.
2. Simply stating a number of relationships without any derivation or reproducing information from sources without input from the candidate, would not demonstrate a good understanding.
3. Candidates should be encouraged to use referenced diagrams and illustrations in this section.
4. DON'T include historical, socio-economic or other non-physics information it uses up word count.
5. Limit N5 and H comments and work.
6. Straight copying from a textbook like Tyler is unlikely to show good understanding, candidates need to 'fill in the blanks'.

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Procedures

Procedures Candidates should include clear, uncluttered, labelled photographs or diagrams to help describe the relevant apparatus. Attempts to sketch apparatus electronically using drawing packages sometimes produces diagrams lacking the clarity necessary for replication. It may be quicker and clearer to produce a sketch using pencil and paper and scan it into the report. A circuit diagram should support the description of apparatus used in a procedure involving an electrical circuit. Values of electrical components should be included. Candidates should describe their procedures, using past-tense passive voice, in sufficient detail to allow replication. Candidates should be encouraged to include the following details: the number of repeats and the range and interval of the independent variable.
The number of procedures will depend on the chosen topic, but the experimental phase of the project normally consists of three or four related experiments. In any event, candidates should be advised to spend approximately 10 to 15 hours in the laboratory obtaining their experimental data.

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Procedures-

"**Procedures** Some candidates did not include labelled diagrams and/or photographs of sufficient clarity. Candidates used schematic diagrams from textbooks on occasion; however, these are not sufficient on their own to be awarded marks. Circuit diagrams were omitted when they would have aided clarity. A number of candidates did not describe their procedures using the past tense, or include the range and interval of the independent variable."
Course report 2025

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Procedures- Apparatus

1. List of apparatus
2. FULL PAGE, LABELLED PHOTOS WITH NO CLUTTER (remove the clutter or put a sheet behind)
3. Hand draw and scan if required
4. Circuit diagrams if an Electrical project (e.g. LCR circuits)

✗ schematics

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Procedures- Descriptions

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

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Results

For data to be considered sufficient, candidates should ensure the number of repeats, and the range and interval of the independent variable, are appropriate for the experiments. Candidates should include all their raw data in the report, not just mean or derived values. If the volume of raw data is large, it should be included in appendices. Candidates should explicitly state all measurements made, rather than simply substituting values into relationships. Additional opportunities to practice graphical analysis and the estimation and combination of uncertainties as part of classwork may support appropriate analysis of raw data, including uncertainties. Candidates should be encouraged to use graphs of an appropriate size with the use of minor gridlines and small data points.

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Results (including uncertainties)

Some candidates did not include all raw data, which prevented them from accessing the data mark. Examples include the time for 10 oscillations, the measured dimensions of a ball bearing, the height of a slope, and the original length of a wire.
Some candidates used software packages to produce graphs that were not of a suitable size, did not include minor gridlines or used data points too large to allow for checking of accuracy of plotting. Some software packages have a default setting for minor gridlines that makes it difficult to check accuracy of plotting due to inappropriate intervals. In addition, some graphs had missing or incorrect labels on axes.
Some candidates did not show sufficient working in their analysis; they should be encouraged to show sample calculations throughout.
Some candidates showed incorrect averaging of calculated or derived values.

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RAW DATA- if its there “give it” is no longer enough

Results (including uncertainties)

Many candidates produced raw data that was sufficient and relevant to the aim(s) of their project, although there were issues in some reports where raw data was omitted for some quantities, with only processed data being included for some quantities.

If you need to use the radius, you will measure the diameter. THIS MUST BE RECORDED CORRECT UNITS on all columns – the units of T^2 are s^2

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Results

1. **<u>All</u> the raw data, if the candidate has oscillations graphs must be in, if they measured the diameter but need the radius, diameter must be shown,**
2. **ALL data, put additional data in an extra table, eg the Moment of Inertia stuff**
3. **USE EXCEL TO DO THE ANALYSIS (or others)**

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Graphs

Many candidates were able to produce suitable graphs of their data and perform relevant analysis using the gradient. To gain full marks in the analysis section, candidates must perform graphical analysis where possible and for a minimum of two of their experiments. Some candidates are using the likes of Excel but omitting to include minor gridlines

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Graphs

1. In at least 2 out of 3 procedures
2. Full size A4 SIZE LANDSCAPE OR PORTRAIT × Bingo dots
3. × google graphs default to 3 or 6 minors to a major!
4. include major and minor gridlines in a colour that prints!
5. Paste as an image to easily turn, OR turn the page OR PRINT DIRECTLY FROM EXCEL AND THEN ADD A BLANK PAGE OR RUN PAGE THROUGH TO PRINT PAGE NO, OR HANDWRITE IT, CAN BE Page 38b etc
6. Need small data points....no bingo dobbers! (4 or 5 point x)
7. Crosses are preferred
8. WHERE POSSIBLE AVOID GOOGLE GRAPHS, PRETTY, BUT PRETTY USELESS

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SAMPLE CALCULATIONS

Show an example of how:-

1. the mean was determined

2. the RU was found

3. The CU and SRU was determined

4. Uncertainties were combined

5. Values were determined and calculated from gradients

6. LINEST values were determined and uncertainties arranged

7. Overall uncertainties were decided.

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Uncertainties

Candidates should be encouraged to quantify all sources of uncertainty in measurements, in particular scale reading uncertainty, calibration uncertainty, and random uncertainty, where appropriate. Candidates should be reminded to include sample calculations for both analysis of data and uncertainties.

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uncertainties

Many candidates showed an awareness of scale reading, random, and calibration uncertainties and/or attempted appropriate combinations of uncertainties. Candidates' use of the LINEST function in Excel again showed improvement; however, some did not present the raw 'box' data. However, few candidates were able to address all three elements of uncertainties successfully.

Note: it is invalid to find the random uncertainty in a calculated value

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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. Fractional uncertainties in measurements raised to a power should be multiplied by the power before using the sum of the square formula
4. Show and use the sum of the square equation
5. Look up Calibration (use Norman Fancey and Gemmell Millar)
6. Use the LINEST but WITH THE BOX
7. Let EXCEL do the work for the candidates.

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Calibration Uncertainties

Manufacturer gives information

Metre stick (wood, plastic) = ± 0.5mm

Steel Rule = ± 0.1mm

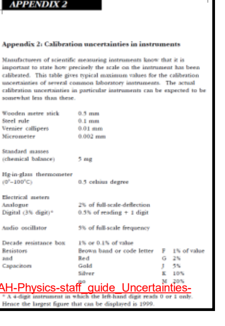
Vernier callipers = ± 0.1mm

Micrometer = ± 0.002mm

Digital meter - **0.5% of reading plus I digit**

e.g. for a reading of 2.56 mA

0.5% of 2.56 = 0.0128 plus 1 digit **(least significant in reading)** gives 0.0228 = ± 0.02mA rounded.



APPENDIX 2

Appendix 2: Calibration uncertainties in instruments

Manufacturers of scientific measuring instruments know that it is important to state how precisely the scale on the instrument has been calibrated. This table gives typical maximum values for the calibration uncertainties of several common laboratory instruments. The actual calibration uncertainties in particular instruments can be expected to be somewhat less than these.

Wooden metre stick	0.5 mm		
Steel rule	0.1 mm		
Vernier callipers	0.01 mm		
Micrometer	0.002 mm		
Standard masses (chemical balance)	5 mg		
Hg-in-glass thermometer (0°–100°C)	0.5 celsius degree		
Electrical meters			
Analogue	2% of full-scale-deflection		
Digital (3½ digit)*	0.5% of reading + 1 digit		
Audio oscillator	5% of full-scale frequency		
Decade resistance box	1% or 0.1% of value		
Resistors	Brown band or code letter	F	1% of value
and	Red	G	2%
Capacitors	Gold	J	5%
	Silver	K	10%
	no	M	20%

* A 4-digit instrument in which the left-hand digit reads 0 or 1 only. Hence the largest figure that can be displayed is 1999.

https://www.mrsphysics.co.uk/advanced/wp-content/uploads/2016/08/AH-Physics-staff_guide_Uncertainties-Norman-Fancey-Gemmell-Millar.pdf

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Random Uncertainty formula

Brackets for the top line

=(max(C3:G3)-min(C3:G3))/counta(C3:G3)

range

Saves you changing the formula if you dump a number (counts filled in boxes)

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Correct Use of Random Uncertainty

1. **For each length used, calculate the random uncertainty and compare this with the scale reading / calibration uncertainty.**
2. **Combine using Pythagorean relationship**
3. **(3 times smaller can be ignored)**
4. **Plot a graph of T^2 against L.**
5. **Use Excel to calculate the gradient of the line of best fit.**
6. **Error bars – good indicator - use in discussion, but not worth the effort, and must be totally correct or will likely be penalised.**

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Incorrect Use of Random Uncertainty

×Calculation of λ using a diffraction grating.
Values calculated for n = 1, 2 & 3.
Incorrect to find mean λ value plus max – min / 3.

✓Must calculate the uncertainty in λ for each value of n.
Comment on best value obtained.
(Accuracy / precision)

✓ **Accuracy - comparison of calculated value to accepted value.**

✓ **Precision - indication of uncertainty in value.**

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Presentation of Results

Have a table with clear headings and units

- For one variable you should show the value of the C.U. S.R.U. A.R.U. (ΔCU ΔSU ΔR)
- Combine these appropriately - no need for fractional or percentage uncertainties at this stage.
- Again give one example of the calculations and state the others were carried out in the same way.
- Show how the uncertainties were combined to give the final absolute uncertainty.
- Round this to one S.F.

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Use of Spreadsheet (Excel)

1. **Highlight numerical columns you want plotted.**
2. **Go to charts - select scatterplot - from chart styles select smallest points possible.**
3. **From menu - select chart layout.**
   Input major and minor gridlines.
   Label axes - remember units.
   Chart title - insert title
4. **From menu - go to trendline**
   select linear trendline
4. **Go to trendline options select "display equation on chart".**
5. **Ensure the graph is expanded to at least half a page.**

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The wrong way to calculate g- but an OK table!

length of thread	Time for three swings (s)							average 3T (s)	T	Period (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~~
										av	9.88

Taking mean value or random uncertainty of g in these values is invalid.

If possible put all the results, including uncertainties in one table

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Some student data to work up uncertainties.

length of thread	Time for three swings (s)							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 3T	fractional uncertainty in T	Fractional Uncertainty in T²	absolute uncertainty in T²	Scale reading uncertainty in l	calibration uncertainty in l	combining absolute uncertainty in l
m	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(av)	(s)	(s)	(s^2)	(s^2)	(s)	(s)	(s)	(s)			(s^2)	(m)	(m)	(m)
0.250	3.04	2.99	2.93	3.08	2.99	2.99	3.00	3.00	0.02	1.00	1.00	1.00	0.02	0.02	0.0250	0.039	0.013	0.026	0.026	0.001	0.0005	0.0011
0.500	3.26	4.36	4.96	4.34	4.46	4.38	4.59	4.34	0.24	1.45	2.09	2.09	0.24	0.02	0.0317	0.246	0.057	0.113	0.237	0.001	0.0005	0.0011
0.750	4.99	5.06	5.06	5.06	5.06	5.06	5.06	5.05	0.01	1.68	2.83	2.83	0.01	0.02	0.0353	0.042	0.008	0.017	0.047	0.001	0.0005	0.0011
1.000	6.24	6.22	6.08	6.06	6.18	6.10	6.14	6.15	0.03	2.05	4.20	4.20	0.03	0.02	0.0407	0.052	0.008	0.017	0.071	0.001	0.0005	0.0011
1.100	6.59	6.40	6.55	6.47	6.47	6.51	6.54	6.50	0.03	2.17	4.70	4.70	0.03	0.02	0.0425	0.054	0.008	0.017	0.078	0.001	0.0005	0.0011
1.200	6.39	6.68	6.56	6.44	6.86	6.45	6.46	6.55	0.07	2.18	4.76	4.76	0.07	0.02	0.0427	0.082	0.013	0.025	0.119	0.001	0.0005	0.0011
1.300	6.32	6.38	6.40	6.64	6.59	6.63	6.39	6.48	0.05	2.16	4.66	4.66	0.05	0.02	0.0424	0.065	0.010	0.020	0.094	0.001	0.0005	0.0011
1.500	7.45	7.62	7.32	7.31	7.55	7.52	7.27	7.43	0.05	2.48	6.14	6.14	0.05	0.02	0.0472	0.072	0.010	0.019	0.118	0.001	0.0005	0.0011
1.750	7.93	7.93	8.11	7.63	7.63	7.68	7.69	7.80	0.07	2.60	6.76	6.76	0.07	0.02	0.0490	0.087	0.011	0.022	0.150	0.001	0.0005	0.0011
2.000	9.01	8.59	8.55	8.41	8.41	8.60	8.82	8.63	0.09	2.88	8.27	8.27	0.09	0.02	0.0531	0.103	0.012	0.024	0.197	0.001	0.0005	0.0011

Find the excel spreadsheet on mrsphysics

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The right way!

length of thread	Time for three swings (s)							average 3T (s)	Period	Period (T)²	a.r.u in 3T	Scale reading uncertainty in 3T	calibration uncertainty in 3T	combining uncertainty in T	Uncertainty in T²	Scale reading uncertainty in l	calibration uncertainty in l	combining uncertainty in l
(m)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(av)	(s)	(s^2)	(s)	(s)	(s)	(s)	(s^2)	(m)	(m)	(m)
0.250	3.04	2.99	2.93	3.08	2.99	2.99	3.00	3.00	1.00	1.00	0.02	0.02	0.0250	0.037	0.077	0.0005	0.0005	0.0007
0.500	3.26	4.36	4.96	4.34	4.46	4.38	4.59	4.34	1.45	2.09	0.24	0.02	0.0317	0.246	0.491	0.0005	0.0005	0.0007

For error bars

Length - increase the scale reading uncertainty to allow for centre of bob or measure 5 times etc.

$mean = \frac{\sum x}{n}$	$\Delta R = \frac{R_{max} - R_{min}}{n}$	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 T² As T is raised to the power 2 then the uncertainty in T² is 2xΔT	ΔT =0.24 $\Delta T^2 = 2 \times 0.24 = 0.491\ s^2$	Scale Reading Uncertainty= increasing to 0.02 s for reaction time. Scale reading uncertainty in length maybe double Now uncertainty in T²and l can be used for error bars	

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CTRL + "¬" brings up the formulae

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	Uncertainty in T²	Scale reading uncertainty in l	calibration uncertainty in l	combining uncertainty in l
(av)	(s)	(s)	(s^2)	(s^2)	(s)	(s)	(s)	(s)	(s^2)	(m)	(m)	
=AVERAGE (B3:H3)	=(MAX($B3:$H3)-MIN($B3:$H3))/COUNTA($B3:$H3)	=I3/3	=K3*K3	=K3^2	=(MAX(B3:H3)-MIN(B3:H3))/COUNTA(B3:H3)	0.01	=0.5/100*I3+0.01	=SQRT(O3^2+P3^2+Q3^2)	=2*R3	0.0005	0.0005	=SQRT(T3^2+U3^2)
=AVERAGE (B4:H4)	=(MAX(B4:H4)-MIN(B4:H4))/COUNTA(B4:H4)	=I4/3	=K4*K4	=K4^2	=(MAX(B4:H4)-MIN(B4:H4))/COUNTA(B4:H4)	0.01	=0.5/100*I4+0.01	=SQRT(O4^2+P4^2+Q4^2)	=2*R4	0.0005	0.0005	=SQRT(T4^2+U4^2)

Don't give the students the spreadsheet, but explain to them how they can devise one and how to put in the formula

Be aware that sometimes EXCEL doesn't give the same answer as you'd calculate as excel doesn't round up it just displays rounded numbers!

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Linest- the easiest way to find the overall uncertainty

Formula for linest- an array

=LINEST(M3:M12,A3:A12,1,1)

=O17/O16*100

4.2

The magic number!

Wow all this for the students to discuss

4.0057989	-0.00452
0.16890437	0.210471
0.985976385	0.27471
562.4663057	8
42.44680528	0.603724

LINEST is PART of uncertainties but not all of it!

Overall uncertainty best obtained from the graph, (ie LINEST)

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Scale Reading Uncertainty

Measuring the length – no need to take into account the scale reading uncertainty at both ends - zero is being aligned with starting point.

Length of pendulum – repeat or **increase** your scale reading uncertainty to increase confidence in estimating centre of bob.

Accept %age uncertainty in sin or tan = %age uncertainty in angle.

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Error Bars- PLEASE DON'T BOTHER

Error bars can be good for evaluation but are absolutely not necessary. In built Excel ones tend to be of no use.

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Use of Spreadsheet (Excel)- DON’T RECOMMEND ERROR BARS

Error Bars - x and y. Set for each individual point.

Format Data Series - allows change in style and size of plotted point.

Linest - uncertainty in gradient . This can be taken as the overall uncertainty $\left(\frac{\Delta m}{m}\right)$ $\textit{fractional uncertainty in gradient} = \textit{fractional uncertainty in the experiment}.$

Expand graph to at least half a page.

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Discussion

Discussion In their evaluations of experimental procedures, candidates should be encouraged, comment on

- the accuracy and precision of their measurements;
- the adequacy of repeated readings;
- the adequacy of the range over which variables are altered;
- the adequacy of control of variables;
- any limitations of their equipment;
- the reliability of their methods;
- and on sources of uncertainties.

In their discussion and critical evaluation of the project as a whole, candidates should comment on

- the reasons for selection of procedures;
- problems encountered during planning;
- modifications to planned procedures;
- interpretation and significance of findings;
- suggestions for further improvements; and
- suggestions for further work.

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Evaluations

1. **Base the evaluations on your uncertainties**
2. **There ought to be numbers in your evaluations!**
3. **If you’ve found a value do your uncertainties include the true value if not why?**
4. **What was the largest uncertainty? How can this be reduced?**
5. **Was the range adequate?**
6. **Were there any rogue points?**
7. **Then follow the list in the MI**

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AI

There was a small number of cases where candidates appeared to have used Artificial Intelligence (AI) to generate sections of their report. This contravenes our guidance on generative artificial intelligence (AI) in assessments.

Do you know if your candidates have generated their own data?

Do you know if candidates are doing their own work?

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NB: Difference between IoP and SQA views

Occasionally there is a little disagreement as to the correct Physics. For the sake of the students put this aside and explain what the QS wants, eg Rounding up and down in uncertainties.

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Appendix 1. Using LINEST- if you have problems

Note: If you have a current version of Microsoft 365, then you can simply enter the formula in the top-left-cell of the output range, then press **ENTER** to confirm the formula as a dynamic array formula. In older versions of Excel, the formula must be entered as a legacy array formula by first selecting the output range, entering the formula in the top-left-cell of the output range, and then pressing **CTRL+SHIFT+ENTER** to confirm it. Excel inserts curly brackets at the beginning and end of the formula for you. For more information on array formulas, see Guidelines and examples of array formulas.

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What is absolute about an uncertainty?

Absolute Uncertainty: is the uncertainty in the measured quantity and has the same units as the quantity itself. *For example if you know a length is 0.428 m ± 0.002 m, the 0.002 m is an absolute uncertainty.*

Fractional Uncertainty: is obtained by dividing the absolute error in the quantity by the quantity itself. The fractional uncertainty is usually more significant than the absolute uncertainty. *For example a 1 mm uncertainty in the diameter of a ball bearing is probably more serious than a 1 mm error in measuring the height of a pupil.* Note that fractional uncertainties are dimensionless.

% Uncertainty When reporting fractional uncertainties it is usual to multiply the fractional error by 100 and report it as a percentage.

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