Subject: A-level Physics	Topic: Practical skills	Year Group: 12/13

enjoy learn succeed

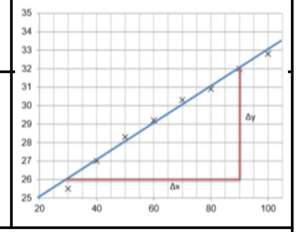
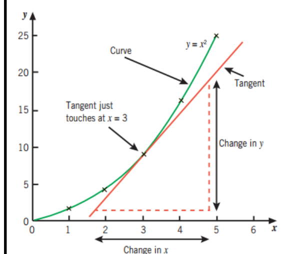
Uncertainties

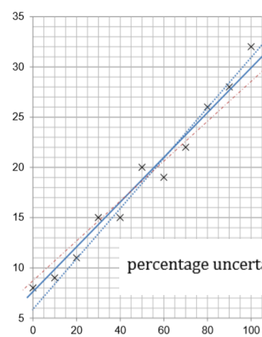
1	In readings	Uncertainty in a reading is no smaller than plus or minus half the smallest division of equipment. E.g. for a thermometer with 1 °C graduations the uncertainty would be ± 0.5 °C.
		For digital equipment such as a voltmeter the uncertainty is often taken to be the same number of decimal places as the value e.g. 2.41 ± 0.01 V.
2	In measurements	For measurements (e.g. ruler measurements) there is an uncertainty of ± 0.5 mm at either end of the ruler so the overall uncertainty is ± 1 mm.
		If measurements are repeated the uncertainty is given by half the range of the measured values.
3	Percentage uncertainty	$\% \, uncertainty = \frac{uncertainty}{value} \times 100$

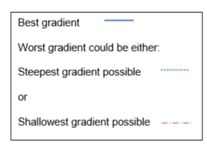
Combining uncertainties

1	a = b + c	Add the absolute uncertainties Δa = Δb + Δc
2	a = b x c	Add percentage uncertainties εa = εb + εc
3	a = b / c	Add percentage uncertainties εa = εb + εc
4	a = b^c	Multiply the percentage uncertainties by the power εa = c × εb
5	Absolute uncertainties (denoted by Δ) have the same units as the quantity. Percentage uncertainties (denoted by ε) have no units.	
6	You may be required to change a % uncertainty back into an absolute uncertainty. Example: 2.41 V ± 5 % is equal to 2.41 V ± 0.12 V since 5 % of 2.41 x (5/100) = 0.12.	

Gradients

1	$Gradient = \frac{\Delta y}{\Delta x}$	
2	Draw a triangle on your graph to show how you calculated the gradient. Make the triangle as big as possible (at least 8 by 8 cm).	
3	Sig figs – how many sig figs can you read each axis to? Quote your gradient to the lowest of these two numbers.	
4	Gradient units are given by y-units divided by x-units.	
5	If the graph has a curved line then you will need to a draw a tangent to determine the gradient of the curve at a particular point.	
6	To find the uncertainty in a gradient, two lines should be drawn on the graph. One should be the "best" line of best fit. The second line should be the steepest or shallowest gradient line of best fit possible from the data.	





$$percentage\ uncertainty = \frac{|best\ gradient - worst\ gradient|}{best\ gradient} \times 100\%$$

Key Vocabulary

1	Accurate	Measurements close to the true value.
2	Random error	They cause readings to be spread about the true value due to results varying in an unpredictable way from one measurement to another.
3	Systematic error	They cause measurements to vary by a consistent amount each time a measurement is made.
4	Zero error	Any indication that a measuring system gives a false reading when the true value of a measured quantity is zero. May result in a systematic uncertainty.
5	Precision	Precise measurements are ones that have little spread about the mean value.
	Measurement	The values taken as the difference between the judgements of two values. E.g. ruler, Vernier calliper, micrometer, protractor, analogue meter, stop clock.
	Reading	The value found from a single judgement when using a piece of equipment. E.g. thermometer, top pan balance, measuring cylinder, digital voltmeter.
6	Repeatable	A measurement is repeatable if the original experimenter repeats the investigation using same method and equipment and obtains the same results.
7	Reproducible	A measurement is reproducible if the investigation is repeated by another person, or by using different equipment or techniques, and the same results are obtained.
8	Resolution	This is the smallest change in the quantity being measured (input) of a measuring instrument that gives a perceptible change in the reading.
9	True value	The value that would be obtained in an ideal measurement.
10	Uncertainty	The interval within which the true value can be expected to lie.

Subject: A-level Physics	Topic: Practical skills	Year Group: 12/13

Tables and significant figures

1	Tables should have clear headings with units indicated using a forward slash before the unit. The body of the table should not contain units.
2	Data should be written in tables to the same number of significant figures. This number should be determined by the resolution of the device being used to measure the data. Example: A length measured to be 60 cm using a ruler with mm graduations should be recorded as 600 mm, 60.0 cm or 0.600 m, and not just 60 cm.
3	When doing calculations involving several measured quantities the answer should always be given to the same number of significant figures as the data with the lowest number of significant figures.

Graphs

1	Never draw axes using difficult scaling e.g. 3, 7, 11 etc.	
2	Axes should always be labelled with the variable being measured and the units. These should be separated with a forward slash. Axes should not be labelled with the units on each scale marking.	
3	The plots should cover at least half of the grid supplied for the graph.	
3	Read ahead in the question to see if you are going to need to y-intercept as it might be appropriate for you to include the origin.	
5	If you need the y-intercept and the origin is not shown on the graph, a) Determine the gradient of your line (m). b) Pick a point on the graph (x,y) and sub the values you read off into the equation $y = mx + c$.	
6	Error bars	• plot the data point at the mean value • calculate the range of the data, ignoring any anomalies • add error bars with lengths equal to half the range on either side of the data point.

Equation of a straight line

1	$y = mx + c$	y	Dependent variable
		m	Gradient
		x	Independent variable
		c	y-intercept
2	In the practical paper you will often be given an equation you have never seen before along with a graph. You will need to manipulate the equation you are given into the form $y = mx + c$.		

3

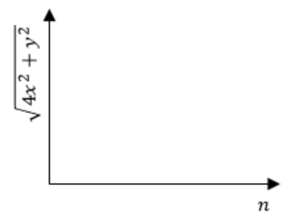
Example:
Rearrange so that $\sqrt{4x^2 + y^2}$ is on the LHS of the equation (since this is on the y-axis).

$$\sqrt{4x^2 + y^2} = n\lambda + b$$

$$y = mx + c$$

Then compare to y = mx + c equation to see what the gradient and y-intercept represent.

So here the gradient represents λ and the y-intercept represents b.



$$n\lambda = \sqrt{4x^2 + y^2} - b$$

Key Vocabulary

1	Accurate	Measurements close to the true value.
2	Random error	They cause readings to be spread about the true value due to results varying in an unpredictable way from one measurement to another.
3	Systematic error	They cause measurements to vary by a consistent amount each time a measurement is made.
4	Zero error	Any indication that a measuring system gives a false reading when the true value of a measured quantity is zero. May result in a systematic uncertainty.
5	Precision	Precise measurements are ones that have little spread about the mean value.
	Measurement	The values taken as the difference between the judgements of two values. E.g. ruler, Vernier calliper, micrometer, protractor, analogue meter, stop clock.
	Reading	The value found from a single judgement when using a piece of equipment. E.g. thermometer, top pan balance, measuring cylinder, digital voltmeter.
6	Repeatable	A measurement is repeatable if the original experimenter repeats the investigation using same method and equipment and obtains the same results.
7	Reproducible	A measurement is reproducible if the investigation is repeated by another person, or by using different equipment or techniques, and the same results are obtained.
8	Resolution	This is the smallest change in the quantity being measured (input) of a measuring instrument that gives a perceptible change in the reading.
9	True value	The value that would be obtained in an ideal measurement.
10	Uncertainty	The interval within which the true value can be expected to lie.