A-Level Physics - Measurements and Their Errors Cheat Sheet

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SI units

mass (m)	kilograms (kg)
length (l)	metres (m)
time (t)	seconds (s)
amount of substance (n)	moles (mol)
temperature (t)	kelvin (K)
electric current (I)	amperes (A)

Derivation of SI Units

A derived unit is comprised of a combination of SI units.

These can be derived by using the definition of the unit, or their equations eg. F=ma

eg. to find the SI units of force (F), multiply the units of mass and acceleration to give kgms^-2 (or N)

This means that every unit can be broken down into its SI base units.

Prefixes

Tera (T)	10^12
Giga (G)	10^9
Mega (M)	10^6
Kilo (K)	10^3
Centi (c)	10^-2
Milli (m)	10^-3
Micro (μ)	10^-6
Nano (n)	10^-9
Pico (p)	10^-12
Femto (f)	10^-15

These prefixes could be added before any SI units

Conversions between units

It is possible to convert between different units of the same quantity. Here are some examples listed below:

1 eV = 1.6 × 10^–19 J

1 kW h = 3 600 000 J or 3.6 MJ (×10^6)

Types of Errors

Random error	Cause variations in both directions and are usually uncontrollable
Systematic error	Caused by faults in the experimental method or apparatus
Zero error	A type of systematic error caused by uncalibrated equipment
Parallax error	A type of systematic error caused by the apparent position of an object due to the viewing angle

Reviewing measurements

Precise	Consistent and fluctuate around a mean value
Accuracy	A measurement that is close to the true value
Repeatability	The original person can redo the experiement and get the same results
Reproducibility	A different person does an experiment differently and gets the same results
Resolution	The smallest change in the quantity being measured that gives a recognisable change in reading

Uncertainty

The bounds in which the accurate value can be expected to lie

They should be given to the same number of significant figures as the data.

Types of Uncertainity

Absolute	Uncertainty given as a fixed quantity
Fractional	Uncertainty as a fraction of the measurement
Percentage	Uncertainty as a percentage of the measurement

Resolution and Uncertainity

Readings are when one value is found

Measurements are when the difference between 2 readings is found

The uncertainty in a reading is +/- half the smallest division

The uncertainty in a measurement is at least +/- 1 smallest division

The ***resolution*** of an instrument will affect its uncertainty

Digital readings and given values will either have the uncertainty quoted, or assumed to be +/- the last significant digit

For repeated data, the uncertainty is *half the range*

Reducing Uncertainity

You can reduce uncertainty in the following ways:

• fixing one end of a ruler so there is only uncertainty in on reading

• measuring multiple times

• (for fractional and percentage) measure larger quantities

Combining Uncertainties

Adding/subtracting data - ADD ABSOLUTE UNCERTAINTIES

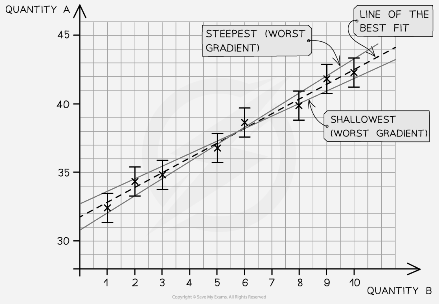
Multiplying/diving data - ADD PERCENTAGE UNCERTAINTIES

Raising to a power - MULTIPLY PERCENTAGE UNCERTAINITY BY POWER

Uncertainties in graphs

Uncertainties are shown as error bars on graphs
A line fo best fit on a graph should go through all error bars (excluding anomalies)
The uncertainity in a gradient can be found by lines of best and worst fit
This can be done using the gradients of the steepest and shallowest lines of best fits
You can also use these two lines to find the uncertainty in the y-intercept

Graph



Estimation of physical quantities

Orders of magnitude are powers of ten which describe the size of an object
These can be used to compare the sizes of objects
Estimation is a skill used to approximate the values of physical quantities, in order to make comparisons, or to check if a value calculated is reasonable.

Variables

Dependant	The variable that is being measured
Indepe-ndent	The variable that is being changed
Control	Other variables that stay the same