OCR B Physics A Level

Module 2: Fundamental Data Analysis

Notes

Uncertainty

Uncertainty is anything which causes measurements to deviate from the **true** value.

This can be due to the instruments used:

- The **resolution** of an instrument limits accuracy, as it must eventually be rounded.

Compare sources of uncertainty by working out the percentage uncertainty:

$$\frac{Uncertrainty}{Measurement} \text{ x } 100$$

Prioritise the largest source of uncertainty when trying to improve methods.

When adding or subtracting uncertainties, add the absolute uncertainties. When multiplying or dividing uncertainties, add the percentage uncertainties.

Uncertainty can be calculated in a number of ways:

- When results are varied, the uncertainty is half the range of values.
- The resolution gives the uncertainty:
    - for a resolution of 1d.p. it is ± 0.05
    - for a resolution of 2d.p. it is ± 0.005, etc.
- You can plot the data on a graph, and draw a line of best fit and a line of worst fit - the difference between the gradients provides the uncertainty.

Base Units

There are 7 **base** units from which all other units are derived; these are called **SI units** (from *Le Systeme International)*.

1. Metre, m
2. Kilogram, kg
3. Second, s
4. Ampere, A
5. Kelvin, K
6. Candela, cd
7. Mole, mol

All other quantities can be expressed in base units, but in many cases **derived** units have been developed. For example, force can be expressed in base units as $kgms^{-2}$, but the derived unit Newtons, N, is more commonly used.

You can often work out the units of a quantity from equations. For example, acceleration is equal to change in velocity / time, and the units are ms^{-2} (or ms^{-1} / s).

Standard Form

Standard form can be used to express very large or very small numbers. This is written as a number with one digit before the decimal place, multiplied by a power of 10.

Examples:

✓ $6 \, x \, 10^{-2}$ = 0.006
✓ $8.23 \, x \, 10^{6}$ = 8230000
X $52.8 \, x \, 10^{4}$
X $0.83 \, x \, 10^{4}$

When using numbers in standard form in mathematical equations etc. remember…

- The powers of 10 are **added** when **multiplying**
- The powers of 10 are **subtracted** when **dividing**

Prefixes

Prefixes are also used to express very large or small numbers.

T	**tera**	$\times 10^{12}$
G	**giga**	$\times 10^{9}$
M	**mega**	$\times 10^{6}$
k	**kilo**	$\times 10^{3}$
c	**centi**	$\times 10^{-2}$
m	**mili**	$\times 10^{-3}$
μ	**micro**	$\times 10^{-6}$
n	**nano**	$\times 10^{-9}$
p	**pico**	$\times 10^{-12}$
f	**femto**	$\times 10^{-12}$

The "Language of Measurements"

Calibration	Determination of the relationship between input and output, and ensuring that the correct output is produced for a given input (for example, that a reading of zero is produced by weighing scales when nothing is on them).
Noise	Random variations superimposed onto a signal.
Resolution	**T**he smallest change that can be detected/displayed by an instrument.
Repeatability	When a procedure can be repeated by the same person with the same equipment/method to obtain similar results.
Reproducibility	When a procedure can be repeated by a different person with different methods/equipment to obtain similar results.
Response time	The time it takes for an instrument to generate an output from an input.
Sensitivity	The change in output for a unit change in output.
Stability	The extent to which repetition produces the same results (see reproducibility and repeatability).
Zero error	When the output produced by zero input is not zero.