COURSE SPECIFICATIONS

UNITS, PREFIXES AND SCIENTIFIC NOTATION

- Appropriate use of units and prefixes.
- SI units should be used with all physical quantities, where appropriate. Prefixes should be used where appropriate. These include pico (p), nano (n), micro (μ), milli (m), kilo (k), mega (M), giga (G) and tera (T).
- Use of the appropriate number of significant figures in final answers. This means that the final answer can have no more significant figures than the value with least number of significant figures used in the calculation.
- Appropriate use of scientific notation.

UNCERTAINTIES

- Knowledge of scale reading, random, and systematic uncertainties in a measured quantity.
- All measurements of physical quantities are liable to uncertainty, which should be expressed in absolute or percentage form.
- Scale reading uncertainty is an indication of how precisely an instrument scale can be read.
- Random uncertainties arise when measurements are repeated and slight variations occur. Random uncertainties may be reduced by increasing the number of repeated measurements.
- Use of an appropriate relationship to determine the approximate random uncertainty in a value using repeated measurements.

$$\textbf{approximate random uncertainty} = \frac{\textbf{maximum value} - \textbf{minimum value}}{\textbf{number of observations}}$$

$$\Delta R = \frac{R_{max} - R_{min}}{n}$$

UNITS PREFIXES & SCIENTIFIC NOTATION

Quantity	Symbol	Unit & Unit Symbol
Mass	m	kilogram, kg
Length	l	metre, m
Time	t	second, s
Temperature	T	degrees Celsius, Kelvin, K
Current	I	ampere, A

PREFIXES

Prefix	Symbol	Multiple	Multiple in full
Tera	T	$x10^{12}$	x1 000 000 000 000
Giga	G	$x10^{9}$	x1 000 000 000
Mega	M	$x10^{6}$	x1 000 000
Kilo	K	$x10^{3}$	x1 000
Centi	C	$x10^{-2}$	÷100
Milli	M	$x10^{-3}$	÷1 000
Micro	μ	$x10^{-6}$	÷1 000 000
Nano	N	$x10^{-9}$	÷1 000 000 000
Pico	P	$x10^{-12}$	÷1 000 000 000 000

SIGNIFICANT FIGURES

- Don’t round up too early in a calculation
- Your answer should have a consistant number of significant figures as the least significant data given in the question. E.g if a question gives you data at 3 significant figures then you should give your answer to 3 significant figure, however through out the question
- **DO NOT** round until the final answer.
- Marks will de deducted in the exam if you use too many significant figures.
- Good planning and experimentation normally avoids this mismatch of values and significant figures.
- Try not to choose apparatus where you can obtain too few or an unnecessarily high number of significant figures.
- Try to obtain all measurements to the same number of significant figures.

SUMMARY
Be realistic about the number of significant figures you quote a value to.
DO NOT write down all the numbers you see on your calculator.
DO use the FIX or SCI button if you feel confident about using them.

OPEN ENDED QUESTIONS

MARKING OPEN-ENDED QUESTIONS

Open-ended questions have no fixed response. Any number of answers may be given which are equally correct (or incorrect
0 marks.- not demonstrated any understanding of the physics of the situation.
1 mark.- demonstrates a limited understanding of the physics of the situation.
2 marks.- demonstrates a reasonable understanding of the physics of the situation.
3 marks. -demonstrates a good understanding of the physics of the situation. This type of response might include a statement of the principles involved, a relationship and the application of these to respond to the problem.

This does not mean the answer has to be what might be termed an "excellent" answer or a complete one.

STRATEGY FOR SOLVING OPEN-ENDED QUESTIONS.

In answering open ended questions you should:

1) read the question - taking care not to skim read.
2) reread the question.
3) **try to understand/define the problem situation and what is asked.**
4) visualise the situation.
5) **draw a diagram and include any relevant information such as speeds, velocities, forces, vector directions etc.**
6) determine and write down

a) relevant physics principles e.g. conservation of momentum
b) note area/topic of physics involved in problem e.g. internal resistance of supplies
c) relationship relevant to variables in the problem.

7) use knowledge of familiar quantities such as body mass, body height, length of running track to create estimated values as required.
8) with the information noted previously solve the problem or do what can be done.
9) reread the response to see if it makes sense and answers the question.

UNCERTAINTIES NOTES

Whenever you do an experiment there will be uncertainties.
There are three types of uncertainty and effects to look out for.

SYSTEMATIC EFFECTS

Systematic uncertainties can arise due to measurement techniques or experimental design.. They include **zero errors**. Sometimes they show up when you plot a graph but they are not easy to recognise, as they are not deliberate. Systematic effects include slow running clocks, zero errors, warped metre sticks etc. The best way to ensure that these are spotted is to acknowledge their existence and go looking for them. Where accuracy is of the utmost importance, the apparatus would be calibrated against a known standard. Note that a systematic effect might also be present if the experimenter is making the same mistake each time in taking a reading.

RANDOM UNCERTAINTIES

These uncertainties cannot be eliminated. They cannot be pinpointed. *examples include fluctuating temperatures, pressure and friction.* Their effect can be reduced by taking **several readings and finding a mean**. Finding the mean is the best possible value obtained to the true value.

READING UNCERTAINTIES

These occur because we cannot be absolutely certain about our readings when taking measurements from scales. Use scales with mirrors where possible, good scales and repeat all measurements.

Repeat <u>all</u> experiments to reduce the reading and random uncertainties. Systematic effects are <u>not</u> improved by taking lots of results.

Which experiment has the best design?

QUANTIFYING UNCERTAINTIES

FIND THE MEAN

$$\text{mean value} = \frac{\Sigma\text{results}}{\text{no. of observations}}$$ (Σ = sum of)

This is the best estimate of the "true" value but not necessary the "true" value

FIND THE APPROXIMATE RANDOM UNCERTAINTY IN THE MEAN (ABSOLUTE UNCERTAINTY)

$$\textit{approximate random uncertainty} = \frac{\textit{maximum value} - \textit{minimum value}}{\textit{number of observations}}$$

$$\Delta R = \frac{R_{max} - R_{min}}{n}$$

At this point the answer should be shown as

MEAN±approx. random uncertainty (UNITS)

FIND THE PERCENTAGE UNCERTAINTY.

$$\textit{percentage uncertainty} = \frac{\textit{approx. random uncertainty}}{\textit{mean value}} \times 100\%$$

stop here and quote the result with a percentage uncertainty

MEAN (UNITS)± percerntage uncertainty (%)

REDUCING UNCERTAINTIES

- Always try to get the most accurate piece of apparatus to do the job.
- Analogue scales can be read to the nearest 0.5 of a scale division.
- Repeat measurements to reduce the random uncertainty in an experiment. You must repeat measurements in your Assignments.

SCALE READING UNCERTAINTY

This value indicates how well an instrument scale can be read.

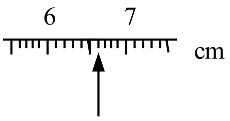
An estimate of reading uncertainty for an **analogue scale** is generally taken as:

± half the least division of the scale.

For a **digital scale** it is taken as

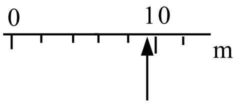
± 1 in the least significant digit displayed.

Examples



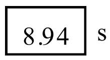
(6.60 ± 0.05) cm

Length lies between (6.55 and 6.65) cm



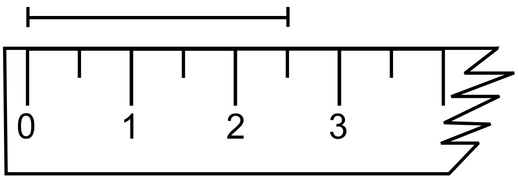
(9.0 ± 0.5) m

Length lies between (8.5 and 9.5) m



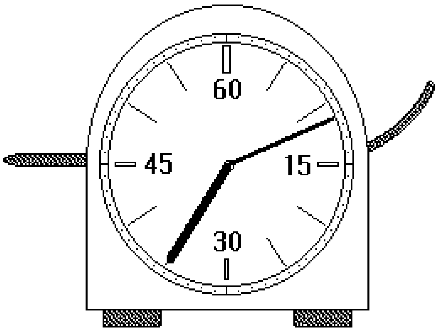
(8.94 ± 0.01) s

Time lies between (8.93 and 8.95) s.



This ruler has half centimetre marks.
The line is about $2\frac{1}{2}$ cm long.

accurate to ½ a scale division,
so uncertainty =0.25/2.5 cm
or % uncertainty=(0.25×100)/2.5%



accurate to ½ a scale division, Each scale division is 1 second (look around the edge)
so uncertainty =0.5seconds/35min 12second
or % uncertainty=(0.5×100)/((35×60)+12)%

Watch out for different scales on a device. Make sure you know which scale you should be using!

OVERALL FINAL UNCERTAINTY

The greatest percentage uncertainty in any one measurement is taken as the overall unicertainty in the experiment
When comparing uncertainties, it is important to take the **percentage** in each.
This percentage uncertainty is often a good estimate of the percentage uncertainty in the final numerical result of the experiment.
eg if one measurement has an uncertainty of 3% and another has an uncertainty of 5%, then the overall percentage uncertainty in this experiment should be taken as 5%