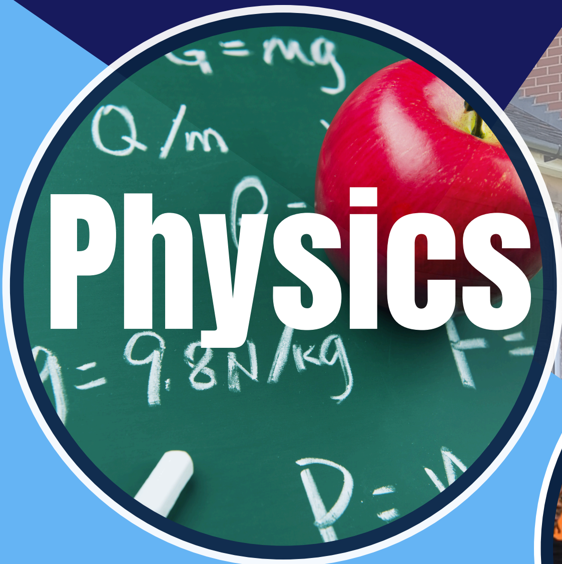
Saint Benedict
Catholic Voluntary Academy

2026
BE PREPARED



Physics

St Ralph Sherwin
Catholic Multi Academy Trust

Physics at A level at SBVA

We cover the Edexcel Physics GCE course – please use the QR code to see the full specification for the course

You will be lent out a textbook for the duration of the course – please look after it and return it in a good condition.

Mandatory equipment for every lesson:

- Your Physics textbook (or an access to a digital copy)
- An A4 folder containing all the
    - notes,
    - a formulae sheet,
    - homework tasks,
    - worksheets for the topic currently being covered –

    this is called your **"working day folder"**

- Pen, pencil, sharpener, rubber
- 30 cm see-through ruler (can be a collapsible one, but not a "bendy" one!)
- Paper for working on
- A way to file the paper that you're working on into the "working day folder" –
    - pre-hole punched pad,
    - plastic wallets, or a
    - holepunch

Useful supplementary sources:

'IsaacPhysics' – contains theory, "how-to" videos, self-marking practice questions and events

'SaveMyExams' – concise notes, topic questions

'PMT' – topic questions, flashcards, help with practical assessment

'PhET' – Useful simulations for all sciences, bringing the theory "to life"

Practical skills in Physics at A level

Physics is a practical subject, which means that whatever anybody thinks – hypothesis – it is only by testing the idea – carrying out an investigation – that we can come to conclusion about whether the idea might be a reasonable explanation of the world (or universe) around us.

Practical skills are central to the work of a physicist and the A level course is built around the development of those skills. It is really important to remember that the term ‘practical skills’ covers a very wide range of requirements at A level. It does not mean just the ability to handle equipment in a school laboratory or know how to use a particular piece of apparatus. It ranges from using mathematics in a practical context to understanding how scientists investigate ideas, how they analyse their data and how they use that data when drawing conclusions.

This guide will explain each of these in more detail. By carrying out a programme of practical work you will develop the skills that a student must have if he or she is to be regarded as a competent practical physicist. You will have to be able to work safely in the laboratory and to manage your time to complete your work in the time allowed. Normally you will be given written instructions so you must be able to follow these carefully.

Over the two years of your A level course your teacher will assess your competence as a practical physicist by letting you carry out sixteen core practicals. At the end of the course your teacher will decide if you have passed as a competent practical physicist. If you pass, then this will be recorded on your A level certificate.

Useful Terms

Accuracy is a measure of the closeness of agreement between an individual test result and the true value. If a test result is **accurate**, it is in close agreement with the true value. An accepted reference value may be used as the true value, though in practice the true value is usually not known.

Anomaly (outlier) is a value in a set of results that is judged not to be part of the inherent variation.

Precision is the closeness of agreement between independent measurements obtained under the same conditions. It depends only on the distribution of random errors (*i.e.* the spread of measurements) and does not relate to the true value.

Repeatability is the precision obtained when measurement results are produced over a short timescale by one person (or the same group) using the same equipment in the same place.

Reproducibility is the precision obtained when measurement results are produced over a wider timescale by different people using equivalent equipment in different (but equivalent) places.

Resolution is the smallest change in the quantity being measured that can be detected by an instrument.

Uncertainty is an estimate attached to a measurement which characterises the range of values within which the true value is asserted to lie. This is normally expressed as a range of values such as 44.0 ± 0.4 (unit).

Task 1: *Link each term on the left to the correct definition on the right.*

Hypothesis	The maximum and minimum values of the independent or dependent variable
Dependent variable	A variable that is kept constant during an experiment
Independent variable	The quantity between readings, eg a set of 11 readings equally spaced over a distance of 1 metre would give an interval of 10 centimetres
Control variable	A proposal intended to explain certain facts or observations
Range	A variable that is measured as the outcome of an experiment
Interval	A variable selected by the investigator and whose values are changed during the investigation

Presenting Data

- When recording your data you should always use a table with headings which include the quantity and its unit, write the unit that you read from the instrument:

You might read a metre rule in centimetres, so head the column of length L say as L/cm, you should also record the resolution of the instrument as ±0.1 cm in the case of the rule.

- Use the number of significant figures (SF) that the instrument gives, so a small length might be 6.4 cm and a longer one 25.6 cm. Recording to the resolution of the instrument is more important than having the same number of sf.
- Be careful that your recorded figure represents what you think you measured:

For example if you record values for mass and write down m = 1.00 kg you are recording the mass to the nearest 10 g, the resolution is much nearer 1 g so you should write M = 1.000 kg.

- Make sure you record enough data and not too much:

Keep your eye on the dependent variable and if it is changing slowly increase the increments in the independent variable.

- You should be flexible and not stick rigidly to your plan if nothing much is changing. Write your readings straight into your table and record everything you measure.

Task 2: A student records the following values for the diameter of a piece of wire:

d/mm	0.27, 0.29, 0.27, 0.77, 0.26

Calculate a mean value for the diameter and explain your choice:

Uncertainties

In everyday English, accuracy and precision have similar meanings, but in physics this is not the case. Their meanings are not the same and the difference must be understood.

An error is the difference between a measured result and the true value, i.e. the value that would have been obtained in an ideal measurement.

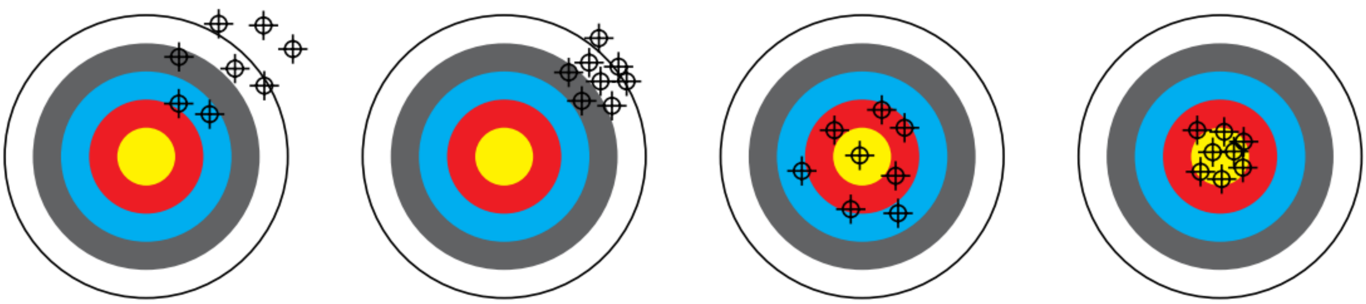
Except for a fundamental constant, the true value is considered unknowable.

An error can be due to random or systematic effects and an error of unknown size is a source of uncertainty.

When you repeat a measurement, you often get different results. There is an uncertainty in the measurement you have taken. It is important to be able to determine the uncertainty in measurements so that its effect can be taken into consideration when drawing conclusions about experimental results.

A measured value is considered to be accurate if it is judged to be close to the **true value** – it cannot be quantified and is influenced by random and systematic errors. The term **precision** denotes the consistency between values obtained by repeated measurements – a measurement is precise if the **values 'cluster' together**. Precision is influenced only by random errors and can be quantified by measures such as standard deviation.

This is best illustrated by considering an archer shooting arrows at a target. In this situation, precision means getting all the shots close together and accuracy means getting them where they should be (the bull's eye!).



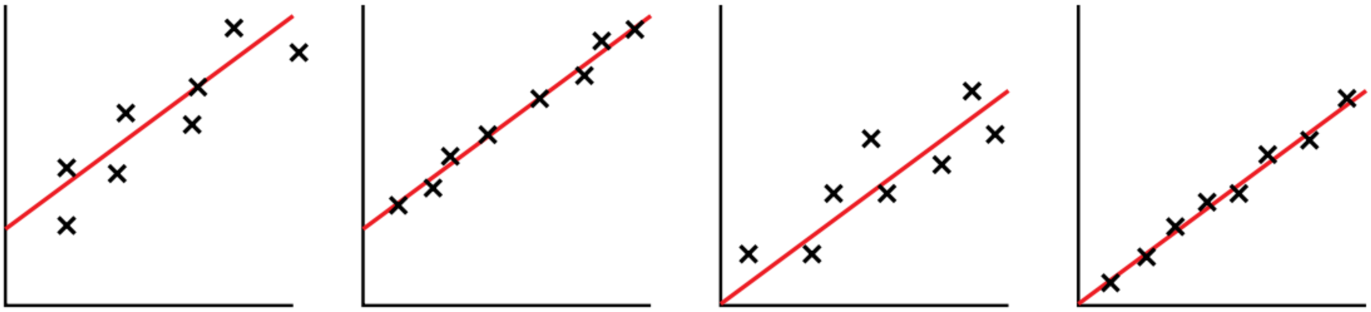
Not precise
Not accurate

Precise
Not accurate

Not precise
Accurate

Precise
Accurate

A good archer may achieve high precision, but if the sights of the bow are not adjusted properly, the accuracy will be poor. This gives rise to a systematic error. A poor archer with correctly adjusted sights will scatter the arrows around the bull or, in terms of physics, will make random errors.



Random and systematic error | Systematic error | Random error | Little random or systematic error

In physics experiments:

- systematic errors can be minimised by taking sensible precautions, such as checking for zero errors and avoiding parallax errors, and by drawing a suitable graph
- random errors can be minimised by taking the average of several repeat measurements and by drawing a graph that, in effect, averages a range of values.

Consider a mechanical micrometer screw gauge:

Such an instrument has high resolution as it can measure to a very small interval – it can be read to 0.01mm – which is the source of uncertainty in a single reading.

- An uncertainty for a single reading, or repeated readings that are the same, will be half the resolution of the instrument.
- For repeated readings that are different, the uncertainty can be taken as being half the range of the readings.

Instrument uncertainties should be stated as ± the least count, and match the number of decimal places of the reported measurement. They should also have only one significant figure if possible. If the number of decimal places in your uncertainty does not match the measurement, round your uncertainty up so that it does.

Task 3: Find the mean value and uncertainty in the following sets of results:

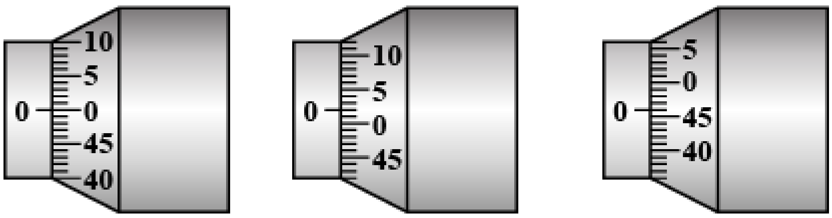
a) 5.2 A, 5.7 A, 5.2 A, 5.5 A, 5.3 A

Answer: ___________±___________ ___ (unit)

b) 1.00cm, 1.00cm, 1.00cm

Answer: ___________±___________ ___ (unit)

You should always check for zero error before using any instrument and make allowance for it if any is present. Examples of zero errors include: weighing scales showing a value with no items placed on them, a micrometer screw gauge that has been overtightened and a newtonmeter that has not been calibrated.
Zero errors are also present in digital instruments, which we often assume will be accurate. You should also understand that the accuracy of digital instruments is determined by the quality of the electronics used by the manufacturer.



(a) No zero error (b) Positive zero error (c) Negative zero error

Task 4: An ammeter has a zero error. This fault will affect (circle the correct option):

A. neither the precision nor the accuracy of the readings.
B. only the precision of the readings.
C. only the accuracy of the readings.
D. both the precision and the accuracy of the readings.

Absolute and Percentage Uncertainties

Absolute uncertainties are expressed as ± the number of units in the measurement (± Δx).

Length = 234 ± 2 mm Period = 1.6 ± 0.3 s

This tells you immediately the maximum and minimum experimental values of a measurement.

Absolute uncertainties have the same units as the stated measurement.

The accuracy of an experiment can be assessed best and quantitatively compared by expressing the uncertainties as percentages:

$$\text{percentage uncertainty} = \frac{\text{uncertainty}}{\text{measured value}} \times 100\%$$

Example: A thermometer with an uncertainty of 0.5 K shows the temperature of water as 98 K, what is the % uncertainty in the reading?

(0.5 / 98) x 100% = ≈ 0.5%

When combining uncertainties, the rules are as follows:

Adding / Subtracting Data

- **Add** together the absolute uncertainties

Multiplying / Dividing Data

- **Add** the <u>percentage</u> uncertainties

Raising to a Power

- **Multiply** the percentage uncertainty by the power

Task 5: A student records measurements of a metre rule. She repeats these from several positions along the rule: Width/mm 28.2, 29.3, 28.9, 29.0, 29.1

Thickness/mm 6.04, 5.94, 5.97, 6.01, 5.99

Mass/g = 106.4

(i) Use these measurements to calculate a value for the density of the rule.

(ii) Calculate the uncertainty in your value for the density.

Graphs

Almost every physics experiment will display data in graphical form and physicists always use a form of their data that produces a straight line – if all goes well with the data.

There is usually a mathematical model for the data and it is this that can be manipulated to give a straight line on the graph. This will happen when the model has been manipulated to be similar to y = mx + c. Some examples are shown in the table:

Mathematical Model	***x*-axis**	***y*-axis**	**gradient**	**intercept**
$V = IR$	I	V	R	Zero
$v^2 = u^2 + 2as$	s	v^2	$2a$	u^2
$I = I_0 \exp^{(\frac{-t}{RC})}$	t	$\ln I$	$\frac{-1}{RC}$	$\ln I_0$
$T = kx^p$	$\ln x$	$\ln T$	p	$\ln k$
$I = I_0 \exp^{(\frac{b}{T})}$				
$T = f^2\lambda^2 \mu$				

Task 6: Complete the bottom two lines to determine a value for b in the first one where the variables are I and T and a value for μ in the bottom line where the variables are T and f.

The axes should be labelled with a unit such as s/m or ln(T/s) – in this way the plots have no units.

The scale should stretch the plots over at last half the graph paper in each direction but should not be difficult to read i.e. multiples of 7s or 3s – take care when plotting time in seconds.

The plots should be accurate to 1 mm and the line of best fit should have plots above it and below. Always tabulate the numbers you are going to use for your graph alongside your data.

A graph in physics is always a scatter graph with a line of best fit shown. Sometimes you may expect a graph through the origin, but this does not actually happen. This is often because of a systematic error in the experiment. In this case, do not force the graph through the origin: you should always draw the line of best fit through your plotted points.