A LEVEL PHYSICS 9702 · EXAM SPECIAL · PAPER 3 (AS) AND PAPER 5 (A LEVEL) · ~7 MIN READ

A Level Physics 9702: Paper 3 Practical and Paper 5 Planning Guide

How to score on the practical papers: tables and significant figures, graphs and gradients, uncertainties, the limitations-and-improvements question on Paper 3, and planning, log graphs, error bars and worst-fit lines on Paper 5.

Paper formats | Tables & units | Significant figures | Graphs & best-fit lines | Gradient & intercept | Uncertainties | Limitations & improvements | Planning

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Paper tag = **where it is examined** DATA & FORMULAE given in the exam C1 A1 B1 how marks are awarded

highlight = comes up again and again HANDY worth memorising Test yourself at the end

IN 30 SECONDS

- **Paper 3 (AS, 2 hours, 40 marks)** has two experiments: Question 1 is usually a graph experiment; Question 2 is a two-reading experiment ending with limitations and improvements.
- **Paper 5 (A Level, 1 h 15 min, 30 marks)** has a planning question (design an experiment) and an analysis question (log graphs, error bars and uncertainties).
- **Most marks come from routine skills:** a well-formed table, a well-scaled graph, a correct gradient, and specific (not vague) evaluation.
- **Uncertainties:** percentage uncertainties add for products and quotients; a power multiplies the percentage uncertainty.

BY THE END YOU CAN

- Record data in tables with correct headings, units and precision.
- Plot graphs, draw best-fit lines and calculate gradients and intercepts correctly.
- Estimate and combine uncertainties.
- Identify specific limitations and improvements.
- Plan an experiment and analyse data with log graphs, error bars and worst-fit lines.

1 Paper 3: taking readings

Tables

- **Headings:** quantity / unit, e.g. "l / cm", "T / s", "$1/T^2$ / s^{-2}". Units in the body of the table lose marks.
- **Raw readings to the precision of the instrument,** consistently: a metre rule to the nearest mm (e.g. 45.0 cm, not 45 cm); a stopwatch reading, then an averaged period.
- **Calculated values:** same number of significant figures as (or one more than) the raw data used.
- **Range and number:** usually at least six sets of readings, spread over as wide a range as the apparatus allows.
- **Repeat timings** and average. Time many oscillations (e.g. 20) to reduce the percentage uncertainty from reaction time.

COMMON MISTAKE

Inconsistent decimal places in a column, or a heading like "Time (s) for 10 oscillations" with no clear quantity. Write "10T / s".

Graphs

- **Scales:** points must fill at least half the grid in both directions. Use 1, 2 or 5 units per 2 cm; awkward scales (3, 6, 7) lose marks.
- **Plotting:** to within half a small square, with small neat crosses or dots.
- **Best-fit line:** thin, straight, with points balanced either side along its length. Don't force it through the origin.
- **Gradient:** use a triangle whose hypotenuse is at least half the length of the line. Read points **on the line**, not data points, and show the coordinates used.
- **Intercept:** read directly only if the x-axis starts at 0; otherwise substitute a point into y = mx + c.

WORKED EXAMPLE

A best-fit line passes through (0.20, 1.35) and (1.10, 5.85). Find the gradient and y-intercept.

1. gradient = (5.85 − 1.35)/(1.10 − 0.20) = **5.0** C1 A1
2. **c = 1.35 − 5.0 × 0.20 = 0.35** A1

2 Uncertainties

Estimating and combining

Situation	Uncertainty
Single reading on a scale	about half the smallest division (often the smallest division if judging is hard)
Repeated readings	half the range
Sum or difference	add absolute uncertainties
Product or quotient	add percentage uncertainties
Power, e.g. x^2	multiply the percentage uncertainty by the power

WORKED EXAMPLE

The length of a pendulum is (80.0 ± 0.2) cm and the period (1.80 ± 0.02) s. Find $g = 4\pi^2 l/T^2$ and its absolute uncertainty.

1. $g = 4\pi^2 \times 0.800/1.80^2 = 9.75\ m\ s^{-2}$ C1
2. % uncertainty = 0.25% + 2 × 1.11% = 2.5% C1
3. **$g = 9.7 \pm 0.2\ m\ s^{-2}$** A1

3 Paper 3: evaluating the experiment

Limitations and improvements

- **Two readings aren't enough** to test a relationship. Improvement: take more readings (for different values) and plot a graph.
- **Be specific:** say what was hard and why, then match it with a precise fix.

Limitation (specific)	Improvement (specific)
Difficult to judge when the ball first hits the floor by eye	use a video camera with a timer, or a light gate / sensor
Difficult to measure the diameter because the wire is thin	use a micrometer screw gauge
Large percentage uncertainty in a short time	time more oscillations, or use a light gate with a data logger
The bob doesn't swing in a single plane	use a fixed clamp and release gently from a marked point
Parallax error reading the rule against the moving object	use a set square, or film against a scale
Temperature of the water changes during the reading	stir and use a thermostatically controlled water bath

COMMON MISTAKE

"Human error", "use more accurate equipment", "repeat readings" with no detail score zero. The 2024 Paper 3 report repeats this every year.

4 Paper 5: planning

Designing the experiment

- **Variables:** state the independent variable (what you change), the dependent variable (what you measure), and the key controlled variables, plus how each is controlled.
- **Method:** a labelled diagram of the working apparatus; how to change and measure each variable, with named instruments (e.g. "micrometer for the diameter", "oscilloscope for the frequency").
- **Analysis:** state the graph to plot and how to test the relationship: "the relationship is valid if the graph is a straight line through the origin"; then how to find the constant from the gradient or intercept.
- **Safety:** a precaution linked to a real hazard in this experiment (e.g. "wear goggles in case the wire snaps"; "use a heat-proof mat for the hot water"). Generic safety scores nothing.
- **Additional detail:** how to make readings more reliable (e.g. repeat and average, check the zero error, wait for thermal equilibrium).

Analysis with logs

$$y = kx^n \Rightarrow \lg y = n \lg x + \lg k$$

gradient n, intercept lg k

$$y = Ae^{-kx} \Rightarrow \ln y = \ln A - kx$$

gradient −k, intercept ln A

- **Error bars:** plot the uncertainty of each point (for logs, the absolute uncertainty in lg y is half of lg(y + Δy) − lg(y − Δy)).
- **Worst acceptable line:** the steepest or shallowest line still passing through all the error bars. Uncertainty in the gradient = |best gradient − worst gradient|.
- **Significant figures for logs:** lg values get as many decimal places as the raw data has significant figures.

COMMON MISTAKE

Plotting lg y but using y-values to find the intercept, or a worst line that misses an error bar. Show the coordinates you used for both lines.

LINKING QUESTION

Measurement, accuracy and precision are in Physical quantities and units; log-linear graphs also appear in Capacitance and Nuclear physics.

Test yourself — cover the answers first

QUICK CHECK

1. What does a column heading need?
2. How do you combine uncertainties for a product?
3. How big should the gradient triangle be?
4. What graph tests $y = kx^n$?
5. Give a specific improvement for timing a falling ball by eye.

Show answers

1. quantity / unit
2. add percentage uncertainties
3. hypotenuse at least half the length of the line
4. lg y against lg x
5. use a light gate or a video camera with a timer

Stuck on a question?

Send it to me on WhatsApp. I read every message.

Want regular help? Send this to your parent →

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