The practical papers reward procedure, observation and arithmetic – not extra chemistry. Almost every mark on Paper 3 is for doing a titration or a qualitative test the way the scheme expects and recording it in the expected form; almost every mark on Paper 5 is for a plan that would actually work.

Titration – the technique the marks live in

Rinse each piece of glassware with the solution it will hold: the burette with the titrant, the pipette with the solution being pipetted, and the conical flask with distilled water ONLY. Rinsing the flask with the solution adds extra moles and is a classic lost mark.

Fill the burette below eye level, run the tap to expel the air bubble in the tip, and record the initial reading – burette readings go to 0.05 cm^3, always with two decimal places (24.00, not 24).

Do a rough titration first, then repeat until two titres agree within 0.10 cm^3, and average only those concordant titres. Averaging a rough titre with accurate ones loses the mark.

Add the last cm^3 dropwise with the flask swirled, and wash the flask walls with distilled water near the end point – the water changes the volume but not the moles.

Concordant titres 一致滴定值 — readings within 0.10 cm^3 of each other; only these are averaged, and you must show which you used

Indicator choice 指示剂选择 — strong acid–strong base: any; strong acid–weak base: methyl orange; weak acid–strong base: phenolphthalein. The indicator must change colour on the vertical part of the curve

State the colour change WITH both colours and the direction: 'colourless to pale pink' for phenolphthalein when alkali is added to acid.

Uncertainty in one burette reading is ± 0.05 cm^3, so in a titre (two readings) it is ± 0.10 cm^3. The percentage uncertainty is $0.10 \div \text{titre} \times 100$ – which is why a larger titre is a better experiment.

Qualitative analysis – what counts as an observation

Record what you SEE, not what you conclude. 'White precipitate, soluble in excess giving a colourless solution' is an observation; 'aluminium ion' is a deduction, and the two are marked separately.

Name the colour and the state every time: 'green precipitate', 'colourless gas', 'brown solution'. 'A precipitate forms' with no colour earns nothing.

'No visible change' is a valid observation and is often worth a mark – never leave a cell blank.

NaOH then excess 氢氧化钠 — white ppt soluble in excess = Al^{3} or Zn^{2} or Pb^{2} ; white ppt insoluble = Ca^{2} or Mg^{2} ; blue = Cu^{2} ; green = Fe^{2} ; red-brown = Fe^{3}

NH then excess 氨水 — distinguishes what NaOH cannot: Cu^{2} gives a blue ppt soluble in excess to a deep blue solution; Zn^{2} dissolves in excess but Al^{3} does not

Gas tests 气体检验 — CO turns limewater milky; H pops with a lit splint; O relights a glowing splint; NH turns damp red litmus blue; Cl bleaches damp litmus; SO turns acidified dichromate from orange to green

Halide test 卤化物检验 — acidify with dilute HNO , then AgNO : white (Cl , dissolves in dilute NH), cream (Br , dissolves in concentrated NH), pale yellow (I , insoluble in NH)

Acidify before AgNO or a carbonate gives a white precipitate too and the test proves nothing. The reason for acidifying is itself examinable.

Enthalpy and rate experiments

For an enthalpy change, use $q = mc\Delta T$ where m is the mass of the SOLUTION (not the solute) and c is 4.18 J g ^{1} K ^{1}. Then divide by the moles of the limiting reagent, and give the sign: exothermic is negative.

Extrapolate a cooling curve back to the moment of mixing to get the true temperature rise – plotting temperature against time and reading the peak underestimates it, because cooling begins immediately.

Heat loss to the surroundings is the dominant error in every calorimetry experiment; a lid and insulation are the standard improvements, and 'the value is less exothermic than the data book' is the expected direction.

For a rate experiment, the rate is 1/t when you time a fixed change (a cross disappearing, a fixed volume of gas). Plotting 1/t against concentration gives a straight line for first order.

Keep the total volume constant when you vary a concentration – dilute with water so only the one variable changes. Forgetting this invalidates the whole set.

Paper 5 – planning

Identify the independent and dependent variables and at least two controlled variables, each with HOW you control it.

Give quantities that would actually work: concentrations, volumes and masses in the range the apparatus can handle. A plan using 500 cm^3 of 5 mol dm ^{3} acid in a test tube scores nothing.

Name the apparatus with its precision – 'a burette reading to 0.05 cm^3', 'a balance reading to 0.01 g'.

Say how you will process the readings into the quantity asked for, and what graph you would plot to test the relationship, naming both axes.

Hazards must be specific to the chemicals used, with a matched precaution: 'concentrated sulfuric acid is corrosive – wear gloves and add acid to water, never water to acid'.

In the analysis question the marks are in the processed column, the graph, the gradient and the final value with its uncertainty – in that order. Do the table carefully before you draw anything.

Recurring errors

Writing burette readings to one decimal place, or a mean titre to more figures than the readings support.

Using the mass of solute instead of the mass of solution in $mc\Delta T$.

Forgetting to convert cm^3 to dm^3 before using $c = n/V$. This single conversion accounts for a large share of all lost calculation marks.

Giving an observation as a deduction ('copper is present') where the question asked what you saw.

Describing an improvement that does not address the error identified – insulation does not fix a titration read to the wrong meniscus.

Omitting state symbols in an equation where the question asked for them, and omitting the charge on an ion in an ionic equation.