

Cambridge OCR GCSE Chemistry A — Chemistry

Topic C7

Practical skills

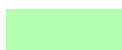
Specification J248 · Cambridge OCR

Free edition

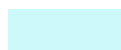
Revision notes for one topic, free to download.

These are the summary notes only. The full edition of this booklet also carries the worked examples, the required practicals and the formula sheets, with every topic in one place.

Colour Codes



Definitions



Diagrams



Notes and warnings



Sub-topic headings

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Cambridge OCR GCSE (9–1) Chemistry A (Gateway Science) J248, until 2025 called OCR · Specification reference C7 · Assessed on every paper: Papers 1 and 2 (Foundation) and Papers 3 and 4 (Higher)

C7 is not a content topic. It is the practical skills topic, and Cambridge OCR states that Paper 1 assesses content from Topics C1–C3 and C7 and Paper 2 assesses content from Topics C4–C6 and C7 — with Papers 3 and 4 the Higher Tier equivalents. Practical skills carry 15% of the marks in the written papers, so about 27 of the 180 marks across the two papers you sit. There is no coursework and no practical exam: everything is assessed in writing.

Define Control variable

- a quantity kept the same so it cannot affect the result; a **fair test** changes only the independent variable.

Define Precise

- measurements clustered closely together; a precise result may still be inaccurate.

Define Repeatable

- the same person, using the same method and apparatus, gets the same results again.

Define Random error

- unpredictable scatter above and below the true value.

Define Anomalous result

- a result lying well outside the pattern of the others.

Define Uncertainty

- the range within which the true value is likely to lie.

Define Valid

- an investigation that measures what it set out to measure and answers the question asked.

Define Practical Activity Group (PAG)

- one of eight groupings into which Cambridge OCR has split the Department for Education's required apparatus and techniques. Chemistry has **PAG C1–C8**.

Define Hypothesis

- a testable idea, based on theory, that predicts what will happen and why.

Define Independent variable

- the one thing you deliberately change. **Dependent variable** — the thing you measure.

Define Accurate

- close to the true value.

Define Resolution

- the smallest change an instrument can detect.

Define Reproducible

- a different person, or different apparatus, gets the same results.

Define Systematic error

- an error shifting every reading the same way by the same amount; a **zero error** is one, caused by an instrument not reading zero when it should.

Define Range

- lowest to highest value of a variable. **Interval** — the gap between values.

C7.1 The practical requirement

Cambridge OCR requires **every learner to complete at least eight practical activities**, which between them must give the opportunity to use **all** the apparatus and techniques listed in the C7 tables. The eight PAGs are OCR's split of Appendix 4 of the DfE's *Biology, chemistry and physics GCSE subject content, July 2015*.

Three points about how this works:

- **The PAGs are groups, not named required practicals.** OCR prescribes no fixed list of experiments, and centres may substitute their own activities provided they cover the same apparatus and techniques at GCSE level — which is why this booklet's practical boxes are labelled by PAG.
- **Some apparatus and techniques appear in more than one PAG.** OCR's footnote states that techniques 1, 2, 4 and 8 below may be covered in any of the groups indicated, so one activity often counts towards several PAGs.
- **The centre must sign a practical science statement** on the NEA Centre Declaration Form, confirming learners had the opportunity to complete at least eight practical activities and made a contemporaneous record of them. Learners who miss the practical work are not barred from the exam but are at a disadvantage in the 15% of marks that assess practical skills.

The eight apparatus and techniques the DfE requires for chemistry, and which the PAG tables distribute:

1. Use of appropriate apparatus to make and record a range of **measurements accurately**, including mass, time, temperature, and volume of liquids and gases.
2. Safe use of appropriate **heating devices** and techniques, including a Bunsen burner and a water bath or electric heater.
3. Use of appropriate apparatus and techniques for **conducting and monitoring chemical reactions**, including appropriate reagents and techniques for the **measurement of pH** in different situations.
4. Safe use of a range of equipment to **purify and separate** chemical mixtures, including evaporation, filtration, crystallisation, chromatography and distillation.
5. **Making and recording observations** during chemical reactions, including changes in temperature and the measurement of **rates of reaction** by a variety of methods such as production of gas and colour change.
6. Safe use and **careful handling of gases, liquids and solids**, including careful mixing of reagents under controlled conditions.
7. Use of appropriate apparatus and techniques to draw, set up and use **electrochemical cells** for separation and production of elements and compounds.
8. Use of appropriate **qualitative reagents and techniques** to analyse and identify unknown samples or products, including gas tests, flame tests, precipitation reactions, and the **determination of concentrations of strong acids and strong alkalis**.

Alongside these, the **use of appropriate scientific diagrams** to set up and record apparatus and procedures is expected in every practical, and **safety is an overriding requirement** throughout.

C7.2 The eight Practical Activity Groups

PAG	Title	OCR's example chemistry activity	Techniques	Where it appears in C1–C6
C1	Reactivity trend	Use of displacement reactions to identify the reactivity trend of Group 7 elements	6	C4.1 (reactivity of metals and halogens), C5.2 (rate as an indicator of reactivity), C6.1 (extraction of copper with carbon)
C2	Electrolysis	Electrolysis of aqueous sodium chloride or aqueous copper sulfate solution, testing for the gases produced	7, 8	C3.4 (electrolysis of molten and aqueous compounds), C6.1 (extraction of metals)
C3	Separation techniques	Use of chromatography to identify the mixture of dyes in an unknown ink	4	C2.1 (paper chromatography, filtration, crystallisation, R_f values)
C4	Distillation	Distillation of a mixture — for example orange juice, cherry cola, hydrocarbons, inks	1, 2, 4	C2.1 (simple and fractional distillation), and applied in C6.2 (crude oil)
C5	Identification of species	Identify an unknown compound using cation tests, anion tests and flame tests	2, 8	C4.1 (transition metal compounds), C4.2 (tests for gases, cations, anions; flame tests)
C6	Titration	Titration of a strong acid and strong alkali to find the concentration of the acid using an appropriate pH indicator	1, 3, 8	C3.3 (neutralisation, pH, pH probes), C5.1 (standard solutions, titration calculations), C6.1 (preparing a fertiliser salt)
C7	Production of salts	Production of a pure, dry sample of a salt	1, 2, 3, 4, 6	C2.1 (crystallisation), C3.3 (soluble salt from an insoluble base), C4.1 (metal with acid), C5.2 (following a rate reaction to its product)
C8	Measuring rates of reaction	Investigate the effect of surface area or concentration on the rate of an acid/ carbonate reaction	1, 5	C2.3 (dissolving), C3.2 (temperature change in reactions), C4.1 (transition metals as catalysts), C5.1 (gas volumes and moles), C5.2 (all rate experiments and catalysis)

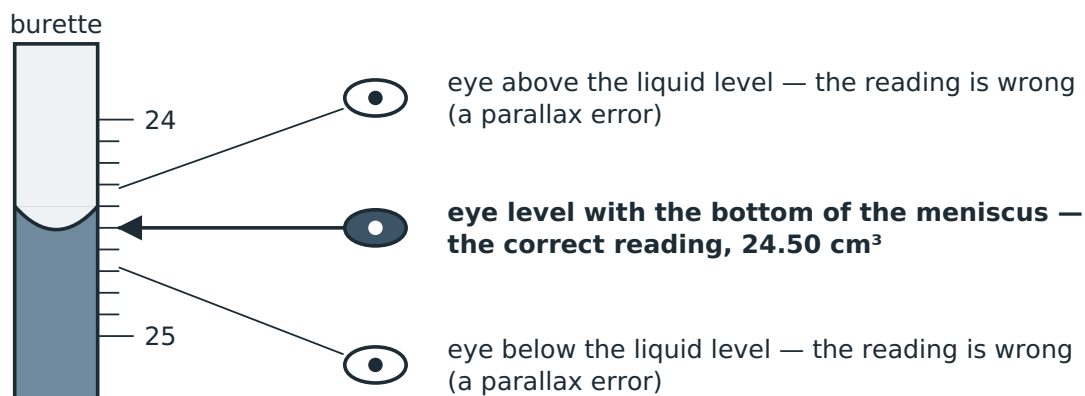
The PAGs are spread unevenly: **PAG C8 touches five sub-topics and PAG C6 three**, so measuring rates, collecting gases and titrating are the likeliest practical questions on any paper. PAGs C3 and C4 sit almost entirely in Topic C2, so they are **Paper 1 and 3** material, and **PAG C1** appears only in C4.1, C5.2 and C6.1, so it is **Paper 2 and 4** material. The groups whose work genuinely spans **both** papers are **C2, C6, C7 and C8**.

C7.3 Planning and variables

Planning questions ask you to **devise a procedure** or **improve one you are given**. Work through the same sequence every time.

1. **State the hypothesis or aim**, using theory: *"increasing the concentration will increase the rate, because there are more particles in the same volume so collisions are more frequent."*
2. **Identify the variables**. Name the **independent** variable and the **range** and **interval** over which you will change it (five values, not two); the **dependent** variable and how you will measure it; and the **control variables** and how you will keep each constant.
3. **Choose apparatus by resolution** — a burette (0.1 cm^3 divisions, so each reading is $\pm 0.05 \text{ cm}^3$ and a titre $\pm 0.10 \text{ cm}^3$) for a titre, a measuring cylinder for a rough 50 cm^3 , a 2-decimal-place balance for 0.05 g of magnesium, a gas syringe rather than water displacement for a soluble gas.
4. **Write numbered steps with quantities**. "Add acid" earns nothing; "add 50 cm^3 of 1.0 mol/dm^3 hydrochloric acid" earns the mark.
5. **Repeat at least three times** at each value and take a **mean**, discarding anomalies.
6. **Include a control** where one is meaningful, and **assess the risks** — hazard, harm, precaution.

Reading a burette at eye level



Clamp the burette vertically, fill it below eye level, run the liquid through the tip to remove the air bubble, and read the bottom of the meniscus against the scale every time.

Choosing apparatus by resolution — the smallest change it can detect

burette — divisions of 0.1 cm³ (resolution 0.1 cm³)

pipette — one fixed volume, 25.0 cm³

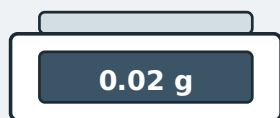
measuring cylinder — 1 cm³ at best, for rough volumes

balance — 0.01 g, or 0.001 g

thermometer — 1 °C, or 0.1 °C for a probe

uncertainty = half the smallest division, so
a burette reading is ± 0.05 cm³ (titre ± 0.10)

A zero error is a systematic error



an empty balance pan

The pan is empty, yet the balance reads 0.02 g, so every mass measured with it is 0.02 g too large. Repeating does not remove this, because the mean is shifted too. Zero (tare) the balance before use.

NOTE

The commonest planning marks lost. Not stating quantities; changing two things at once; choosing a range too narrow to show a trend; forgetting to say *how* a control variable is controlled (a water bath, not "keep the temperature the same"); and omitting repeats. A plan that cannot be followed by someone else without asking questions is not yet finished.

C7.4 Recording and processing data

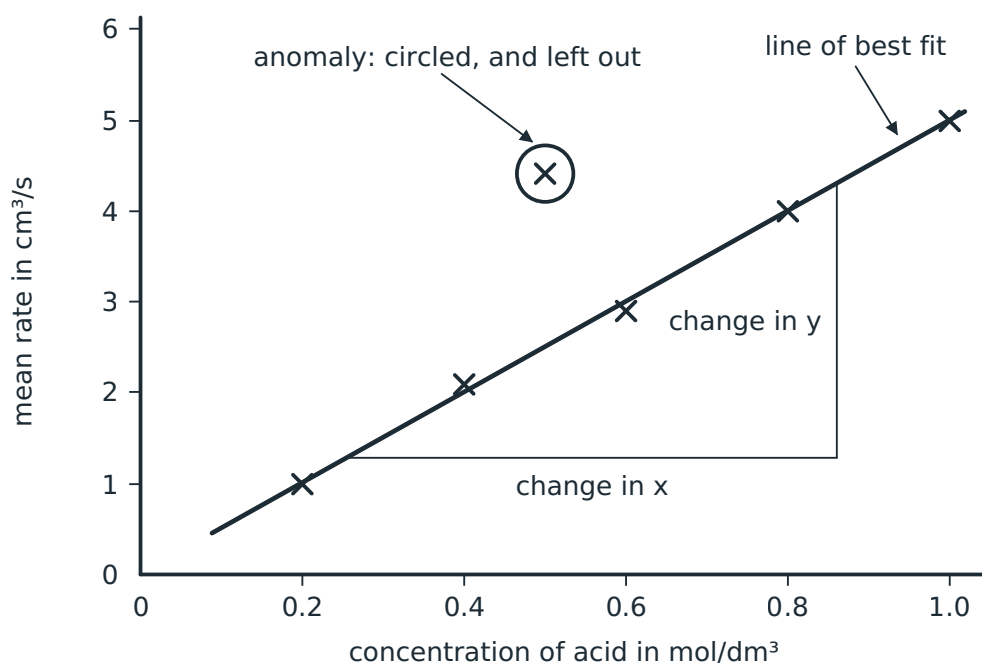
Tables. Draw the table **before** you start. The **independent** variable goes in the first column, the **dependent** variable in the ones after it. Put **quantities and units in the headings only** — "Volume of gas in cm^3 " — never beside each number. Record every reading to the **same number of decimal places**, fixed by the instrument's resolution, and give repeats, the mean and any processed quantity ($1 \div t$, rate) their own labelled columns.

Means. Add the repeats and divide by how many — but **exclude anomalies first** and say you have done so. In a titration this is the concordance rule: discard the rough titre and average only titres within 0.10 cm^3 of each other.

Graphs. Independent variable on the x-axis, **dependent** on the y-axis. Use scales covering **at least half of each axis**, rising in steps of 1, 2, 5 or 10 — never 3 or 7. Label both axes with quantity and unit and plot small neat crosses. Draw a **straight line of best fit**, with roughly equal numbers of points each side, or a **smooth curve** — never join the dots, and do not extend the line beyond the data unless asked to extrapolate. Circle anomalies and **ignore them when drawing the line**.

Getting numbers out of a graph. For the **gradient of a straight line** (M4d), build a **large triangle** on the line, read Δy and Δx off the axes and divide; the units are y-axis units over x-axis units. For a **rate at one instant** on a curve (M4e), place a ruler touching the curve at that point and matching its slope, draw a long **tangent** and take its gradient — small triangles magnify drawing errors. When **reading off**, draw construction lines and leave them on the graph; they earn a mark.

Drawing a graph that earns the marks, and taking a gradient from it.



Drawing the graph

- the variable you changed goes on the x-axis, the one you measured on the y-axis
- label each axis with the quantity and its unit
- use scales in steps of 1, 2, 5 or 10 that fill at least half of each axis
- plot small neat crosses and never join the dots

Taking a gradient

- build a large triangle on the line, then divide the change in y by the change in x
- the unit is the y-axis unit over the x-axis unit

C7.5 Analysing and evaluating

Describing. Say what the data show, with the numbers — direction, shape, any turning point. *"The rate rose from 1.2 cm³/s at 0.5 mol/dm³ to 2.4 cm³/s at 1.0 mol/dm³ — doubling the concentration doubled the rate."* Quoting figures is almost always worth a mark.

Explaining. Give the chemistry behind the pattern in the topic's own vocabulary — collision frequency, activation energy, equilibrium position, intermolecular forces. Describing is not explaining.

Concluding. Answer the original question, say whether the hypothesis is **supported**, and say **how far** the evidence goes. Results at three temperatures do not license a claim about all temperatures.

Evaluating. Name a **specific** weakness, say **what effect** it had and **in which direction**, and give a **realistic** improvement: *"Some carbon dioxide escaped before the bung was fitted, so every volume was too low — a systematic error; holding the solid in a small tube inside a pre-stoppered flask would prevent it."* Avoid the empty answers — "be more accurate", "do it more carefully", "human error".

Judging the whole investigation. Was it **valid** — did it measure what the question asked? Were the controls sufficient, the range wide enough, the repeats close enough to support the conclusion? Would an independent group repeating the work strengthen it? Cambridge OCR also expects you to recognise the value of **peer review** and of communicating results to a range of audiences (WS1.1i).

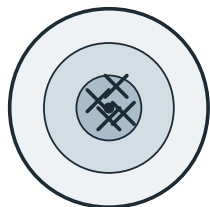
C7.6 Accuracy, precision, repeatability, reproducibility and error

These five terms are examined directly, and are routinely muddled.

Term	Meaning	How to improve it
Accuracy	How close a measurement is to the true value	Calibrate instruments; remove systematic errors; use the right apparatus
Precision	How closely repeated measurements agree with each other	Use instruments of higher resolution ; repeat and take a mean
Resolution	The smallest change the instrument can detect	Choose a burette over a measuring cylinder; a 3- decimal-place balance over a 1-decimal-place one
Repeatability	The same person , same method, same apparatus gets the same results	Repeat the measurement at least three times
Reproducibility	A different person , or different apparatus, gets the same results	Publish the full method; have another group repeat the work
Validity	The investigation measures what it set out to measure	Control all the other variables; use a suitable range and a control

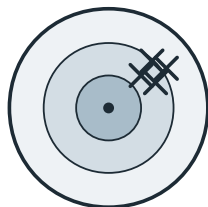
Accuracy and precision are independent. A burette with a bubble in the tip gives titres agreeing to 0.05 cm^3 — very **precise** — but every one is too large, so they are **inaccurate**. Careless readings that scatter widely may still average out close to the truth: accurate on average, imprecise.

Accuracy and precision are independent, and each is spoiled by a different kind of error.



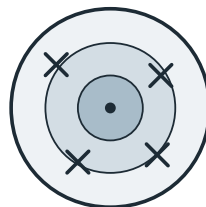
Precise and accurate

The results agree with each other and with the true value.



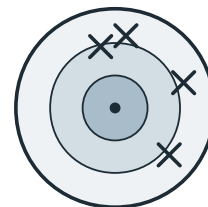
Precise, not accurate

The results agree with each other but are all shifted the same way — a systematic error.



Accurate, not precise

The results scatter, but their mean is close to the true value — random error.



Neither

The results scatter and their mean is a long way from the true value.

Each cross is one repeat measurement; the centre of the target is the true value. Repeating and taking a mean reduces random error. Only correcting the method or the instrument removes a systematic error.

The two kinds of error.

- **Random errors** vary unpredictably in size and direction — judging the exact moment a cross disappears, reading a scale slightly differently each time, small variations in room temperature. They make results **scatter**, and are reduced by **repeating and taking a mean**, and by using instruments of higher resolution.
- **Systematic errors** shift every reading the same way — a balance that reads 0.02 g with nothing on it (a **zero error**), an unrinsed burette diluting the acid, gas escaping while the bung is fitted, a thermometer touching the beaker wall. Repeating does **not** remove them, because the mean is shifted too. They are removed by **checking and correcting the method or the instrument**.

Anomalous results should be identified, circled on the graph, excluded from the mean, and — where you can — explained: a chip that was much larger than the others, an unnoticed leak, a misread scale.

Uncertainty. For a single analogue reading, take **half the smallest division**; a burette needs two readings, so the uncertainty in a titre is $\pm 0.10 \text{ cm}^3$. For a set of repeats, use **half the range**. Quote a result as, for example, $24.50 \pm 0.10 \text{ cm}^3$, and never give more significant figures than the data justify.

C7.7 Maths skills for practical work

Cambridge OCR states that at least **20% of the marks** assess mathematical skills, at a level appropriate to the tier. These are the skills Appendix 5f lists for chemistry, with where they bite in practical work.

Code	Skill	Where it is used
M1a	Recognise and use expressions in decimal form	All calculations
M1b	Recognise and use expressions in standard form	The Avogadro constant; concentrations; atomic sizes
M1c	Use ratios, fractions and percentages	Reacting ratios; percentage yield; atom economy; unit conversions
M1d	Make estimates of the results of simple calculations	Checking a titration answer is sensible
M2a	Use an appropriate number of significant figures	Every final answer
M2b	Find arithmetic means	Concordant titres; repeats
M2c	Construct and interpret frequency tables and diagrams, bar charts and histograms	Presenting data on pollutants, LCA and atmospheric composition
M2h	Make order of magnitude calculations	Atomic sizes; evaluating the significance of CO ₂ data
M3a	Understand and use the symbols =, <, <<, >>, >, α, ~	Proportionality in rate work
M3b, M3c	Change the subject of an equation; substitute values with correct units	$n = c \times V$; $m = n \times M_r$
M4a	Translate information between graphical and numeric form	Reading yield–temperature graphs
M4b	Understand that $y = mx + c$ is a linear relationship	Volume of gas against mass of reactant
M4c	Plot two variables from experimental data	Every rate graph
M4d	Determine the slope and intercept of a linear graph	Mean rate
M4e	Draw and use the slope of a tangent as a measure of rate of change	Rate at an instant from a curve
M5b	Visualise and represent 2D and 3D forms , including 2D representations of 3D objects	Giant structures; displayed formulae
M5c	Calculate areas, surface areas and volumes	Surface area to volume ratio in rate work

C7.8 Safety, risk and answering practical questions

Risk assessment is expected in any plan, in three parts — **hazard, harm, precaution**: "*Concentrated hydrochloric acid is corrosive and could burn skin or eyes, so wear eye protection, use a dilute solution and wash splashes off at once.*" The recurring hazards in this course: **acids and alkalis** are irritant or corrosive; **chlorine, sulfur dioxide and ammonia vapour** are toxic and need ventilation or a fume cupboard; **hydrogen** is flammable, so no naked flames; **lead and barium compounds** are toxic; hot apparatus and roaring flames burn; sealed apparatus in a gas-producing reaction builds up pressure.

Cambridge OCR's command words are listed in section 3c, and they control what a practical answer needs. The ones that matter most here: **describe** (what happens or what to do, no reasons), **explain** (reasons, using chemistry), **suggest** (apply what you know to an unfamiliar situation; more than one answer may be acceptable), **evaluate** (weigh evidence for and against and reach a supported conclusion), **justify** (support a statement with evidence), **calculate** (show your working) and **plan** (a method someone could actually follow).

Practical questions are often set on an experiment you have **never done**, using apparatus from a PAG you have. The skills transfer: identify the variables, judge the resolution of the apparatus, look for the systematic error, read what the graph is telling you, and answer in the chemistry of the topic it comes from.