IGCSE CHEMISTRY 0620 · ATP SHORTCUTS · ~11 MIN READ

Chemistry ATP Shortcuts (Paper 6)

The practical skills sheet: apparatus and readings, titrations, collecting gases, rates and energy, chromatography, planning and evaluating. Written for the practical and alternative-to-practical papers.

Apparatus | Titration | Gases | Rates | Chromatography | Planning | Evaluating

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No tag = **Core** (everyone) EXTENDED Extended only highlight = comes up again and again
HANDY worth memorising Test yourself at the end

IN 30 SECONDS

- **Practical marks come from habits:** correct apparatus, readings to the right accuracy, tables with units, and observations that say exactly what you saw.
- **Titration:** rinse, use a white tile, add dropwise near the end-point, ignore the trial titre and average only titres within 0.2 cm^3.
- **Planning and evaluating** use numbers and named apparatus, one changed variable, the controls, repeats and a clear way to reach a conclusion.

1 Apparatus and readings

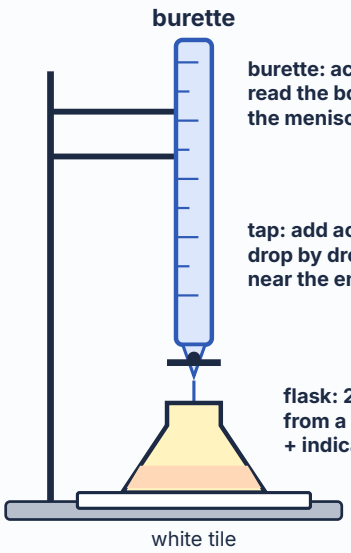
Choosing the right apparatus

Apparatus	Use it for	Reads to
burette	adding an accurate volume of acid	0.05 cm^3
pipette	a fixed volume such as 25.0 cm^3	exactly 25.0 cm^3
measuring cylinder	an approximate volume of liquid	1 cm^3
gas syringe	measuring the volume of a gas	1 cm^3
thermometer	temperature	0.5 °C or 1 °C
balance	mass	0.01 g or 0.1 g
stopwatch	time	0.1 s

- **Read the bottom of the meniscus** at eye level, so your eye is level with the liquid. Reading from above or below is a parallax error.
- **Burette readings** are recorded to 0.05 cm^3. They end in 0 or 5 in the second decimal place, such as 23.45 cm^3.
- **Tables:** put the unit in the column heading (time / s), not in each cell. Write the same number of decimal places in a column.
- **Use the right apparatus for the job:** a measuring cylinder is not accurate enough when a question needs an accurate volume.

2 Titration

Method and calculation



Example results (cm³)

	trial	1	2	3
final	24.60	24.25	24.30	24.80
initial	0.00	0.10	0.00	0.50
titre	24.60	24.15	24.30	24.30

Ignore the trial titre.
Titres 1 to 3 are within 0.2 cm³, so average them:
(24.15 + 24.30 + 24.30) ÷ 3
= 72.75 ÷ 3 = 24.25 cm³

Record burette readings to 0.05 cm³, for example 24.25, or to 0.1 cm³.
Titre = final − initial.

Add the acid to the alkali until the indicator just changes colour. That is the end-point. The alkali is in the flask because it is measured with the pipette.

- **Rinse** the burette with the acid and the pipette with the alkali. Rinse the flask with water only.
- **Use a white tile** under the flask so you can see the colour change. Swirl all the time.
- **Do a trial titration first,** adding acid quickly. Then repeat slowly and add it **dropwise** near the end-point.
- **Concordant results** are titres within 0.2 cm³ of each other. Average those only and **never** include the trial.
- **Indicators:** methyl orange is red in acid and yellow in alkali (orange at the end-point). Phenolphthalein is colourless in acid and pink in alkali.
- **Titre = final reading − initial reading.** The mean titre goes into the calculation.

WORKED EXAMPLE

Titres of 24.15, 24.30 and 24.30 cm³ are concordant. Find the mean titre, and the concentration of the HCl if 25.0 cm³ of 0.100 mol/dm³ NaOH is neutralised. NaOH + HCl → NaCl + H_2O

1. mean titre = (24.15 + 24.30 + 24.30) ÷ 3 = 72.75 ÷ 3 = **24.25 cm³**
2. n(NaOH) = 0.100 × 0.0250 = 0.00250 mol
3. n(HCl) = 0.00250 mol (1 : 1)
4. **c(HCl) = 0.00250 ÷ 0.02425 = 0.103 mol/dm³ to 3 significant figures**

COMMON MISTAKE

Including the **trial titre** in the average, or averaging results that are not concordant.

COMMON MISTAKE

Reading the burette from above, or **forgetting to fill the jet** below the tap before starting.

3 Collecting gases

Choosing a method

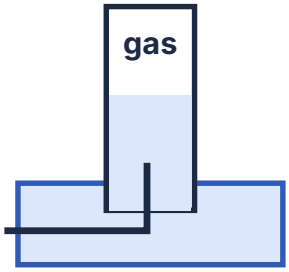
Gas syringe



measures the volume of any gas

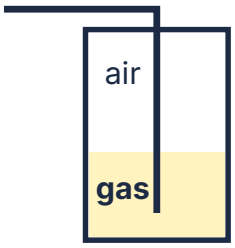
gas pushes the plunger out

Over water



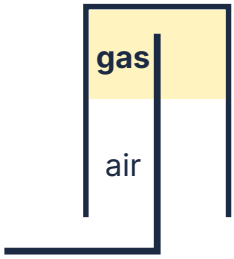
gas must not be very soluble (H_2, O_2)

Downward delivery



gas denser than air: CO_2, Cl_2, SO_2, HCl

Upward delivery



gas less dense than air: H_2, NH_3, CH_4

Match the method to the gas. Collect over water or with a gas syringe when you need to measure volume.

- **Gas syringe:** accurate volume of any gas, for rate experiments. Check the plunger moves freely.
- **Over water:** the gas must be insoluble or only slightly soluble. Fill the tube with water first and keep it inverted.
- **Downward delivery:** for gases denser than air, such as carbon dioxide and chlorine.
- **Upward delivery:** for gases less dense than air, such as hydrogen and ammonia. Ammonia is very soluble, so it cannot be collected over water.
- **Drying a gas:** pass it through concentrated sulfuric acid. Not for ammonia, which needs quicklime (calcium oxide).

4 Rates and energy

Rates of reaction

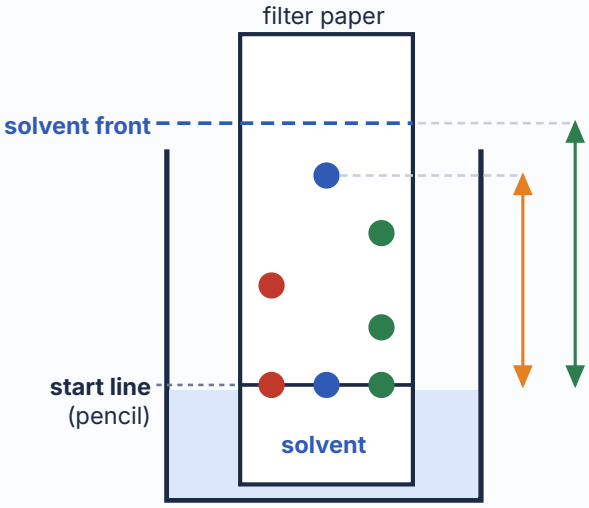
- **Measuring the rate:** volume of gas against time (gas syringe), loss of mass on a balance (gas escapes), or the time for a cross under the flask to disappear.
- **A faster reaction** has a steeper line on a graph of volume or mass change against time. The line becomes flat when the reaction has finished.
- **Rate = gradient** of the line. Draw a tangent for the rate at one moment EXT.
- **Change only one variable at a time:** concentration, temperature, particle size or catalyst. Keep the others the same.
- **Explain with particles** EXT: higher concentration or temperature means more frequent collisions, and more particles with enough energy to react (temperature).

Temperature change

- **Use a polystyrene cup with a lid,** stir, and record the highest or lowest temperature. Use a measuring cylinder to measure the same volume each time.
- **Exothermic:** the temperature rises. **Endothermic:** the temperature falls.
- **Heat loss** to the surroundings makes the measured temperature change smaller than the true value. A lid and insulation reduce this.

5 Separation and purity

Chromatography, crystals and salts



Rf = distance moved by the spot ÷ distance moved by the solvent

orange arrow: spot, 80 mm
green arrow: solvent, 100 mm

Rf = 80 ÷ 100 = 0.8

Rf is always between 0 and 1.
Draw the start line in pencil, because ink would run.
Keep it above the solvent level.
Same Rf on the same paper and solvent means the same substance.
Two spots = a mixture.

A pure substance gives one spot. A mixture gives more than one. Rf values let you identify substances.

$$\text{Rf} = \frac{\text{distance moved by the spot}}{\text{distance moved by the solvent}}$$

measure both from the start line. Rf has no units

- **Filtration** separates an insoluble solid from a liquid. **Evaporation** and **crystallisation** recover a dissolved solid.
- **Crystallisation:** heat the solution until it is saturated (a drop on a cold glass rod forms crystals), then leave it to cool and crystallise slowly. Filter, wash with a little cold water and dry.
- **Simple distillation** separates a solvent from a solution. **Fractional distillation** separates liquids with different boiling points.
- **Soluble salt from an insoluble base or carbonate:** add the solid to the acid until some is left over (excess), filter, then evaporate and crystallise.
- **Pure substances** have a sharp melting point and a fixed boiling point. Impurities lower the melting point and make it melt over a range.

6 Identifying unknowns

Writing observations

- **Observation** = what you see, hear or smell. **Conclusion** = what it tells you. Do not give the conclusion unless the question asks for it.
- **Use exact words:** "white precipitate", "fizzing or effervescence", "gas turns limewater milky", "colourless solution". Avoid "clear" when you mean "colourless".
- **Do the tests in order** and use fresh samples. Add reagents a drop at a time, then **in excess**.
- **Say the colour before and after** when there is a change, for example "orange to colourless".
- **Gas tests:** use damp litmus paper, a lighted or glowing splint, or limewater. Name the gas only after the test is positive.

7 Planning and evaluating

The 6-mark plan

- **1. Apparatus:** name each item with its size, for example "25 cm^3 measuring cylinder" or "250 cm^3 conical flask".
- **2. Amounts:** give numbers, such as "25.0 cm^3 of 1.0 mol/dm^3 hydrochloric acid" and "1.0 g of magnesium".
- **3. Change one variable** (the independent variable) over at least 5 values, such as temperature of 20, 30, 40, 50 and 60 °C.
- **4. Measure the dependent variable** and how, such as "time for the cross to disappear" or "volume of gas every 30 s".
- **5. Controls:** list at least two things you keep the same, with values, and how you control them.
- **6. Repeat and average,** then say how you will use the results (draw a graph, or find the highest temperature rise).

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Errors and improvements

Error or weakness	Improvement
gas escapes before the bung is put in	use a divided flask, or hold the solid in a thread and drop it in
heat loss to the surroundings	use a polystyrene cup and a lid
judging when the cross disappears	use a light sensor, or the same observer each time
a measuring cylinder is not accurate	use a burette or a pipette
only one set of results	repeat and calculate a mean
a temperature changes during the reaction	use a water bath to keep it constant

- **Accurate** means close to the true value. **Reliable** means repeats give similar results. **Precise** readings have small spread.
- **Safety:** wear eye protection, tie back long hair, handle hot objects with tongs, and never point a heated test tube at anyone.

EXAM TIP

Use numbers in plans: "25.0 cm^3 pipette", "1.0 g of magnesium", "every 30 seconds". Vague plans lose marks.

8 Test yourself

Test yourself — cover the answers first

QUICK CHECK

1. To how many cm^3 are burette readings recorded?
2. Why is a white tile placed under the titration flask?
3. How close must titres be to be concordant?
4. Should the trial titre be included in the mean?
5. Which apparatus gives exactly 25.0 cm^3 of alkali?
6. Why must the start line in chromatography be drawn in pencil?
7. A spot moved 3.0 cm and the solvent moved 5.0 cm. Calculate Rf.
8. Which method collects hydrogen?
9. How does a lid help in a temperature change experiment?
10. Name two control variables in a rate experiment with magnesium and acid.

EXAM-STYLE

11. A student measures the volume of gas made when marble chips react with acid. Suggest two improvements to make the results more reliable. [2]
12. Plan an investigation into how temperature changes the rate of reaction between sodium thiosulfate and dilute hydrochloric acid. [6]
13. A titration needs 24.40, 24.30 and 25.20 cm^3 for three runs after a trial of 25.00 cm^3. Which results should be averaged, and what is the mean? [3]

Show answers

1. 0.05 cm^3 (second decimal place 0 or 5)
2. to make the colour change easier to see
3. within 0.2 cm^3
4. no
5. a pipette
6. ink would dissolve and move up the paper
7. 0.60
8. over water, or upward delivery
9. it reduces heat loss
10. concentration and volume of acid, mass or length of magnesium, temperature
11. repeat the experiment and calculate a mean
    use the same size and mass of marble chips each time
    use a gas syringe and put the bung in quickly
12. use a measuring cylinder to put 50 cm^3 of sodium thiosulfate in a conical flask on a cross
    heat or cool the solution to 20, 30, 40, 50 and 60 °C and record each temperature
    add 5 cm^3 of acid, start a stopwatch and swirl
    stop the watch when the cross can no longer be seen
    keep the volumes and concentrations the same each time
    repeat each temperature and calculate a mean, then plot time against temperature
13. 24.40 and 24.30 are within 0.2 cm^3 of each other
    25.20 is not concordant with them, and the trial is never used
    mean = (24.40 + 24.30) ÷ 2 = 24.35 cm^3

Stuck on a question?

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

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Ask Riyaz Sir

Want regular help? Send this to your parent →