Titration

Answers, marking points and revision notes | AQA GCSE Chemistry 8462 only (not Combined Science)

GCSE science required practicals

This practical online

Answers

1 Name the piece of equipment used to measure the 25.0 cm^3 of sodium hydroxide, and explain why it is used instead of a measuring cylinder. (2 marks)

A volumetric pipette (with a pipette filler). It measures one fixed volume much more accurately than a measuring cylinder.

Marking points

- Volumetric pipette
- More accurate / smaller uncertainty than a measuring cylinder

2 Give two reasons why the conical flask is placed on a white tile and swirled during the titration. (2 marks)

The white tile makes the colour change of the indicator easier to see. Swirling mixes the acid with the alkali so the colour change is not reached too early in one part of the flask.

Marking points

- White tile: colour change easier to see
- Swirling: mixes the reactants so the end point is accurate

3 Give two things Priya must keep the same in each accurate titration, other than the concentration of the acid. (2 marks)

The volume of sodium hydroxide (25.0 cm^3) and the indicator used, with the same number of drops.

Marking points

- Volume of alkali
- Indicator type / number of drops (or judging the same end point colour)

4 Dilute hydrochloric acid is an irritant. Describe one hazard when filling the burette with the acid and how to reduce the risk. (2 marks)

Liquid can splash or overflow into the eyes when pouring above eye level. Fill the burette below eye level using a small funnel, pour slowly, and wear safety goggles.

Marking points

- Splashing / overflowing into eyes or onto skin
- Fill below eye level with a funnel / pour slowly / wear goggles

5 Calculate the titre for titration 3. (1 mark)

22.90 cm^3

Titre = final reading - start reading

Titre = 24.10 - 1.20 = 22.90 cm^3

Marking points

- 22.90 cm^3

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6 Which accurate titrations are concordant? Explain your answer. (2 marks)

Titrations 2, 3 and 4 (22.95, 22.90 and 22.95 cm^3). They are all within 0.10 cm^3 of each other. Titration 1 (23.20 cm^3) is 0.25 cm^3 higher, so it is not concordant.

Marking points

- Titrations 2, 3 and 4
- They are within 0.10 cm^3 of each other; titration 1 is not

7 Calculate the mean titre using only the concordant results. Give your answer to 2 decimal places. Show your working. (3 marks)

22.93 cm^3

Concordant titres: 22.95, 22.90, 22.95

Total = 22.95 + 22.90 + 22.95 = 68.80 cm^3

Mean = 68.80 / 3 = 22.933...

Mean titre = 22.93 cm^3

Marking points

- Uses titrations 2, 3 and 4 only
- (22.95 + 22.90 + 22.95) / 3
- 22.93 cm^3

8 Suggest why the rough titre is larger than the accurate ones, and why it is not used in the mean. (2 marks)

In the rough run the acid is added quickly, so it is easy to go past the end point and add too much. It is only a guide to where the end point is, so it is not accurate enough to include.

Marking points

- Acid added quickly so the end point is overshot
- It is only a guide / not accurate enough to include

9 **Higher tier**

Use your mean titre from question 7 to calculate the number of moles of hydrochloric acid that reacted. The acid concentration is 0.100 mol/dm^3. (2 marks)

0.002293 mol (2.293 x 10^{-3} mol)

Volume = 22.93 / 1000 = 0.02293 dm^3

Moles = concentration x volume

Moles = 0.100 x 0.02293

Moles of HCl = 0.002293 mol

Marking points

- Volume converted to dm^3: 22.93 / 1000 = 0.02293
- 0.002293 mol

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10 **Higher tier**

The equation is NaOH + HCl → NaCl + H_2O. Use your answer to question 9 to calculate the concentration of the sodium hydroxide solution in mol/dm^3. Give your answer to 3 significant figures. Show your working. (3 marks)

0.0917 mol/dm^3

Ratio NaOH : HCl = 1 : 1, so moles of NaOH = 0.002293 mol

Volume of NaOH = 25.0 / 1000 = 0.0250 dm^3

Concentration = moles / volume

Concentration = 0.002293 / 0.0250 = 0.09172

Concentration = 0.0917 mol/dm^3 (3 significant figures)

Marking points

- Moles of NaOH = 0.002293 (1 : 1 ratio)
- Divides by 0.0250 dm^3
- 0.0917 mol/dm^3

11 **Higher tier**

Convert your answer to question 10 into a concentration in g/dm^3. The relative formula mass (M_r) of NaOH is 40. (2 marks)

3.67 g/dm^3

Mass concentration = concentration in mol/dm^3 x M_r

Mass concentration = 0.09172 x 40 = 3.6688

Mass concentration = 3.67 g/dm^3

Marking points

- 0.0917 x 40
- 3.67 g/dm^3 (3.7 accepted)

12 Oliver forgot to remove the air bubble from the tip of his burette, and it came out during his first accurate titration. Explain the effect on his titre, and say how he should have avoided it. (3 marks)

The burette reading changes as the bubble leaves, but no acid has gone into the flask for that volume. So his titre would be too large. Before taking the start reading, he should open the tap and run a little acid into a waste beaker until the tip is completely full of liquid.

Marking points

- Titre recorded is too large
- Because the bubble's volume is counted as acid added when it was not
- Run some acid through the tap before the start reading so the tip is filled

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13 Burette readings are recorded to the nearest 0.05 cm^3. Explain the difference between the results being precise and being accurate, using Priya's titres as an example. (3 marks)

Precise means the repeat results are close together: titres 2, 3 and 4 are within 0.05 cm^3 of each other, so they are precise. Accurate means close to the true value. The results could be precise but still inaccurate if, for example, the acid was not exactly 0.100 mol/dm^3, because every titre would be wrong by the same amount.

Marking points

- Precise = repeats close together / little spread
- Accurate = close to the true value
- Example: concordant titres are precise, but a systematic error (wrong acid concentration, misread meniscus every time) could make them inaccurate

14 A school has a bottle of dilute sulfuric acid with no label for its concentration. A technician has potassium hydroxide solution of known concentration. Plan a titration to find the volume of the potassium hydroxide solution that exactly neutralises 25.0 cm^3 of the acid. (6 marks)

Wear goggles. Use a pipette and pipette filler to put exactly 25.0 cm^3 of the sulfuric acid into a conical flask, and add a few drops of methyl orange, which is red in acid. Rinse a burette with potassium hydroxide solution, fill it using a funnel below eye level, and run a little through so there is no air bubble. Record the start reading at the bottom of the meniscus. Put the flask on a white tile and add the alkali while swirling until the indicator turns yellow; this is the rough titre. Repeat with fresh acid, adding the alkali quickly to about 2 cm^3 before the rough value, then drop by drop until one drop makes the colour change. Record the final reading and work out the titre. Repeat until there are at least two titres within 0.10 cm^3 of each other and take the mean of these.

Marking points (any 6, with the method in a logical order)

- Pipette 25.0 cm^3 of acid into a conical flask
- Add a few drops of a suitable indicator
- Fill the burette with potassium hydroxide; read the start volume
- Add alkali while swirling, on a white tile
- Add drop by drop near the end point until the colour changes
- Record the final reading; titre = final - start
- Rough titration first
- Repeat to get concordant titres (within 0.10 cm^3) and find the mean
- Goggles worn / pipette filler used

How it is marked

- 5-6 marks: a full, logical plan using a pipette and burette correctly, with an indicator, careful dropwise end point and repeats to concordant results that are averaged.
- 3-4 marks: the main titration steps are there but some detail is missing, such as no concordant results or no mention of adding drop by drop.
- 1-2 marks: some correct equipment or one or two steps named, but no clear method that would give a reliable titre.

Revision notes: the method

Aim: To find the volume of an acid that exactly neutralises a measured volume of an alkali, and use it to work out the concentration of the alkali.

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Equipment

- burette and clamp stand
- 25.0 cm^3 volumetric pipette and pipette filler
- conical flask
- small funnel
- white tile
- dilute hydrochloric acid of known concentration
- sodium hydroxide solution of unknown concentration
- indicator (phenolphthalein or methyl orange)
- safety goggles

Method

1. Rinse the pipette with a little of the sodium hydroxide solution, then use the pipette filler to measure exactly 25.0 cm^3 of it into a clean conical flask.
2. Add a few drops of indicator to the flask and stand it on a white tile under the burette.
3. Rinse the burette with a little hydrochloric acid, then fill it using a funnel. Remove the funnel and let some acid run through so there is no air bubble in the tip.
4. Read the burette at the bottom of the meniscus, with your eye level with it, and record the start reading to the nearest 0.05 cm^3.
5. Do a quick rough titration: add acid while swirling the flask until the indicator changes colour, and note roughly how much was needed.
6. Refill the flask with a fresh 25.0 cm^3 of alkali and indicator. Add acid quickly to within about 2 cm^3 of the rough value, then add it drop by drop, swirling, until one drop makes the colour change permanently.
7. Record the final burette reading and subtract to find the titre.
8. Repeat until you have at least two titres within 0.10 cm^3 of each other (concordant), then take the mean of the concordant titres.

Variables

- **Independent:** Not a fair-test investigation; the quantity being found is the volume of acid needed to neutralise the alkali.
- **Dependent:** The titre: the volume of acid added from the burette until the indicator changes colour (final reading minus start reading).
- **Control:** Volume of alkali measured with the pipette (25.0 cm^3); Concentration of the acid; Same indicator and number of drops each time; Same end point colour each time

Hazards

Hazard	What could happen	How to reduce the risk
Sodium hydroxide solution	Irritant or corrosive to the eyes and skin	Wear safety goggles; wash splashes off with plenty of water
Filling the burette above head height	Acid splashing into the eyes or overflowing	Take the burette down or fill it below eye level using a funnel, slowly
Using the pipette	Swallowing the solution	Always use a pipette filler, never your mouth

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Key points

- Concordant titres are within 0.10 cm^3 of each other; only these go into the mean, never the rough titre.
- Burette readings are recorded to 2 decimal places, ending in 0 or 5.
- The pipette measures the alkali; the burette adds the acid. Do not mix them up.
- Swirl the flask and add the acid drop by drop near the end point.
- Read the bottom of the meniscus at eye level.
- Moles = concentration x volume in dm^3: divide cm^3 by 1000 first.

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