

Finding concentration by titration

Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet

Name: _____ Date: _____ Class: _____

These problems train titration technique and calculation: reading burettes, choosing results, working out moles and using mole ratios, from simple one-step conversions to dilution, purity and error analysis.

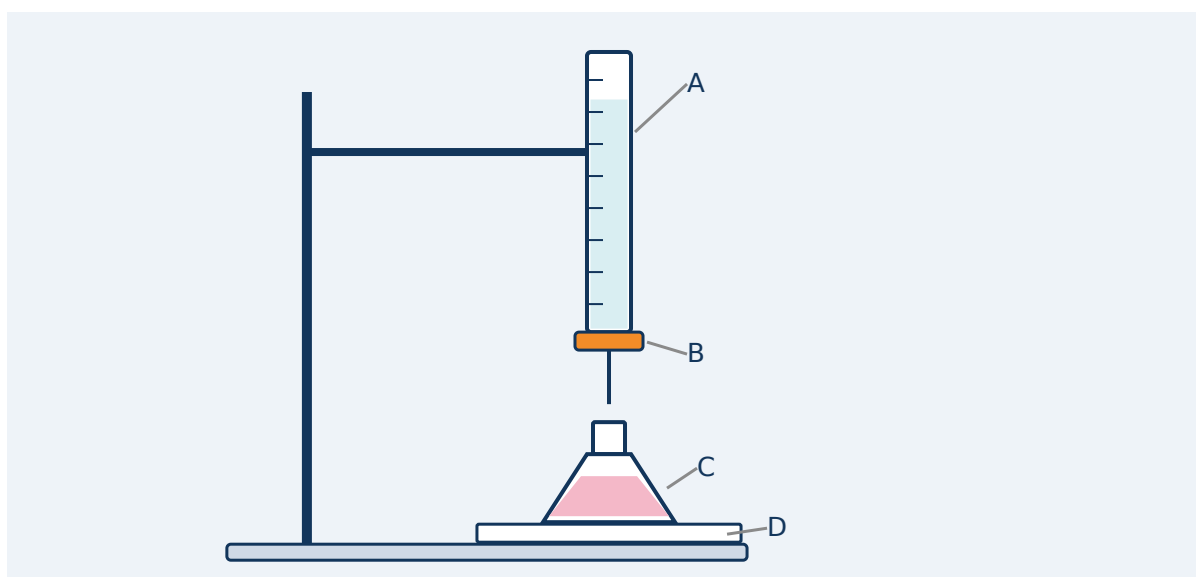
The set suits GCSE, IGCSE, O Level and Class 9-10 students preparing for the required practical. Always convert cm^3 to dm^3 , show the mole ratio, and give answers to three significant figures.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE C4 RP

Problem 1 Name the apparatus (easy)

Look at the diagram of a titration set-up.

1. Name the piece of glassware labelled A and say what it holds.
2. Name the part labelled B.
3. Explain why a white tile is placed under the flask C.

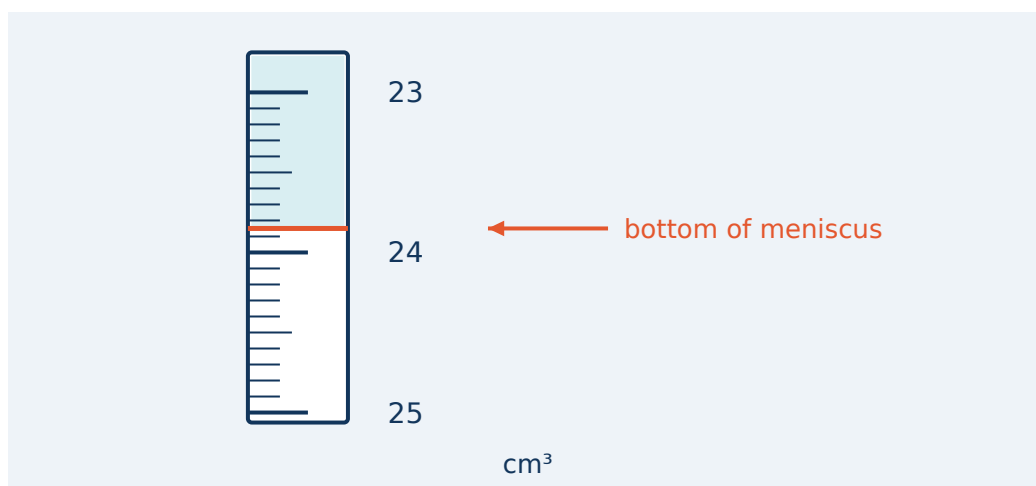


Titration set-up for Problem 1.

Problem 2 Reading burette results (easy)

Wanjiru records a titration. The start reading was 0.40 cm^3 . The diagram shows the final level.

1. Read the final level.
2. Calculate the titre.
3. Explain why the eye must be level with the meniscus.



Final burette level for Problem 2 (cm³).

Problem 3 Which indicator? (easy)

Phenolphthalein is pink in alkali and colourless in acid. Alkali is in the flask and acid is in the burette.

1. State the colour in the flask at the start.
2. State the colour change at the end point.
3. Explain why the indicator is added in only a few drops.

Problem 4 Moles from c and V (easy)

Calculate the moles in each sample.

1. 25.0 cm³ of 0.200 mol/dm³ NaOH.
2. 15.0 cm³ of 0.100 mol/dm³ HCl.
3. 22.5 cm³ of 0.0500 mol/dm³ KOH.

Problem 5 Choosing the mean (easy)

Emma in Leeds obtains titres: rough 23.20, then 22.40, 22.50 and 22.45 cm³.

1. Explain why the rough titre is not used.
2. Show that the three accurate titres are concordant.
3. Calculate the mean titre.

Problem 6 Technique steps (easy)

1. Explain why the burette is rinsed with the acid it will contain.
2. Explain why air bubbles in the burette tip must be removed.
3. Explain why the flask is swirled while the acid is added.

Problem 7 Alkali in the flask (medium)

Kofi in Accra titrates 25.0 cm³ of NaOH against 0.100 mol/dm³ HCl. The mean titre is 20.00 cm³.

1. Calculate the moles of HCl.
2. Calculate the concentration of NaOH in mol/dm³.
3. Calculate the concentration in g/dm³ (Ar: Na = 23, O = 16, H = 1).

Problem 8 How strong is the vinegar? (medium)

Chiamaka in Lagos pipettes 25.0 cm³ of vinegar into a 250 cm³ volumetric flask and makes it up with water. She titrates 25.0 cm³ of this solution with 0.100 mol/dm³ NaOH: CH₃COOH + NaOH → CH₃COONa + H₂O. The mean titre is 21.50 cm³ (Ar: C = 12, H = 1, O = 16).

1. Calculate the concentration of the diluted vinegar.
2. Calculate the concentration of the original vinegar.
3. Calculate the mass of ethanoic acid in 1 dm³ of vinegar.

Problem 9 Testing limewater (medium)

Esther in Nairobi titrates 25.0 cm³ of limewater, Ca(OH)₂, with 0.0200 mol/dm³ hydrochloric acid. The mean titre is 15.50 cm³: Ca(OH)₂ + 2HCl → CaCl₂ + 2H₂O (Ar: Ca = 40, O = 16, H = 1).

1. Calculate the moles of HCl.
2. Calculate the moles and the concentration of Ca(OH)₂.
3. Calculate the concentration in g/dm³.

Problem 10 Drain cleaner (medium)

A 10.0 cm³ sample of drain cleaner (sodium hydroxide) is diluted to 500 cm³. A 25.0 cm³ portion needs 20.00 cm³ of 0.100 mol/dm³ HCl.

1. Calculate the concentration of the diluted solution.
2. Calculate the dilution factor.
3. Calculate the concentration of the original drain cleaner in mol/dm³ and in g/dm³ (Ar: Na = 23, O = 16, H = 1).

Problem 11 Sodium carbonate and acid (medium)

Na₂CO₃ + 2HCl → 2NaCl + H₂O + CO₂. Bilal in Lahore finds that 25.0 cm³ of a sodium carbonate solution needs 22.00 cm³ of 0.100 mol/dm³ HCl (Ar: Na = 23, C = 12, O = 16).

1. Calculate the moles of HCl used.
2. Calculate the concentration of sodium carbonate in mol/dm³.
3. Calculate the concentration in g/dm³.

Problem 12 Analyse the results table (medium)

Mei in Singapore records burette readings for 25.0 cm³ of alkali.

Run	Start (cm ³)	Final (cm ³)	Titre (cm ³)
Rough	0.00	25.40	?

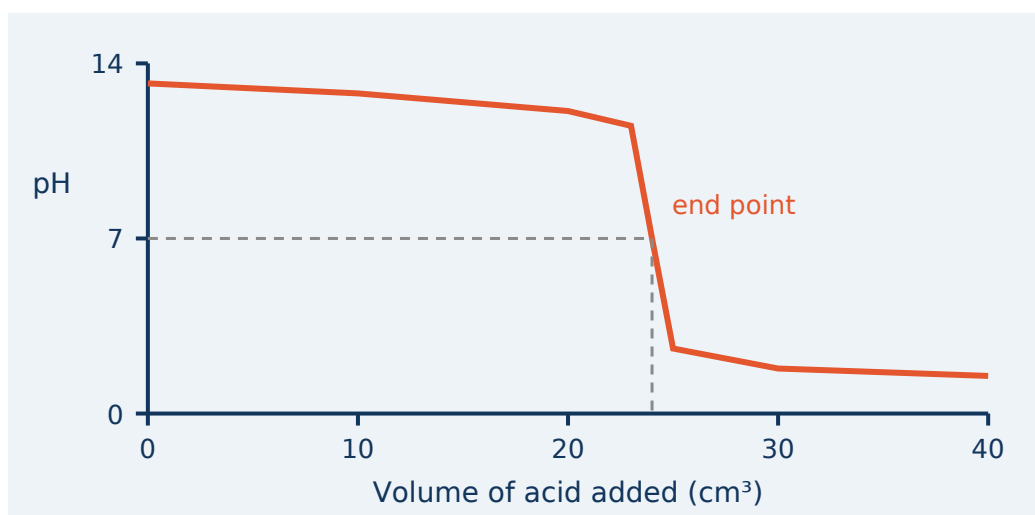
Run	Start (cm ³)	Final (cm ³)	Titre (cm ³)
1	0.00	24.30	?
2	24.30	48.50	?
3	0.20	24.45	?

1. Complete the table.
2. Choose the concordant titres and calculate the mean.
3. The acid concentration is 0.100 mol/dm³ and the reaction is 1 : 1. Calculate the concentration of the alkali.

Problem 13 Read the pH curve (medium)

The graph shows acid added to 20.0 cm³ of sodium hydroxide of concentration 0.150 mol/dm³.

1. Read the volume of acid at the end point.
2. State the pH at the end point.
3. Calculate the concentration of the acid.



pH curve for acid added to alkali: the steep drop shows the end point.

Problem 14 Household ammonia (medium)

Ammonia solution cleaner is analysed: 10.0 cm³ is diluted to 250 cm³, and 25.0 cm³ of this needs 23.00 cm³ of 0.100 mol/dm³ HCl: $\text{NH}_3 + \text{HCl} \rightarrow \text{NH}_4\text{Cl}$ (Ar: N = 14, H = 1).

1. Calculate the concentration of the diluted solution.
2. Calculate the concentration of the cleaner in mol/dm³ and in g/dm³.
3. Explain why methyl orange is suitable but phenolphthalein is not.

Problem 15 Purity of sodium hydroxide (medium)

Diego in Texas dissolves 2.00 g of impure sodium hydroxide pellets in water and makes the volume up to 250 cm³. A 25.0 cm³ sample needs 22.50 cm³ of 0.200 mol/dm³ HCl (Ar: Na =

23, O = 16, H = 1).

1. Calculate the moles of NaOH in the 25.0 cm³ sample.
2. Calculate the mass of NaOH in the whole 250 cm³.
3. Calculate the percentage purity.

Problem 16 Making a standard solution (hard)

Aarav in Pune prepares 250 cm³ of a standard solution of sodium carbonate of concentration 0.0500 mol/dm³. He then titrates 25.0 cm³ of it with hydrochloric acid of unknown concentration. The mean titre is 20.80 cm³ (Ar: Na = 23, C = 12, O = 16).

1. Calculate the mass of Na₂CO₃ he must weigh.
2. Write the equation and state the mole ratio.
3. Calculate the concentration of the hydrochloric acid.

Problem 17 Acid in lemon juice (hard)

Lemon juice contains citric acid, C₆H₈O₇, which reacts with sodium hydroxide: C₆H₈O₇ + 3NaOH → Na₃C₆H₅O₇ + 3H₂O. A 10.0 cm³ sample of juice is diluted to 100 cm³. A 25.0 cm³ portion needs 24.00 cm³ of 0.100 mol/dm³ NaOH (Ar: C = 12, H = 1, O = 16).

1. Calculate the moles of NaOH used.
2. Calculate the concentration of citric acid in the diluted juice.
3. Calculate the concentration in the original juice in mol/dm³ and in g/dm³.

Problem 18 Which errors matter? (hard)

A student makes four mistakes in different attempts. For each, state whether the calculated concentration of the alkali would be too high, too low or unaffected, and explain.

1. The burette was rinsed with water but not with acid.
2. The conical flask was rinsed with water and left wet.
3. An air bubble in the burette tip escaped during the run.
4. The student added acid past the end point (the solution turned acid).

Problem 19 Checking a label (hard)

A bottle of toilet cleaner is labelled 1.00 mol/dm³ hydrochloric acid. Kofi in Accra dilutes 10.0 cm³ to 250 cm³ and titrates 25.0 cm³ of it with 0.0500 mol/dm³ NaOH. The mean titre is 20.50 cm³.

1. Calculate the concentration of the diluted acid.
2. Calculate the concentration of the cleaner.
3. Calculate the percentage difference from the label and state whether it is within ±5%.

Problem 20 An unknown acid (hard)

A student dissolves 0.600 g of a solid monoprotic acid HX (one H⁺ per molecule) in water to make 100 cm³. A 25.0 cm³ portion needs 20.00 cm³ of 0.100 mol/dm³ NaOH.

1. Calculate the moles of acid in the 25.0 cm³ portion.
2. Calculate the moles of acid in the whole 100 cm³.
3. Calculate the relative formula mass of HX.
4. State how the result would change if the acid were diprotic and the same data were used.