Titration calculations

Worked solutions

GCSE science calculations

This topic online

1 In a titration, the burette reading at the start is 0.50 cm^3. At the end point the burette reading is 23.70 cm^3.

Calculate the titre. (1 mark)

Titre = final reading - initial reading

titre = 23.70 - 0.50

23.20 cm^3

2 Zainab does not refill her burette between two titrations. The table shows her readings for the second titration.

	Burette reading in cm^3
Initial	12.35
Final	36.80

Calculate the titre for the second titration. (1 mark)

Titre = final reading - initial reading

titre = 36.80 - 12.35

24.45 cm^3

3 Leon does a titration five times. His titres are shown in the table.

Titration	**Rough**	**1**	**2**	**3**	**4**
Titre in cm^3	25.60	24.90	24.95	25.40	24.85

Concordant results are within 0.10 cm^3 of each other.

Calculate the mean titre using only the concordant results. (2 marks)

Leave out the rough titre and 25.40 (not concordant)

concordant: 24.90, 24.95, 24.85

Mean = total ÷ number of results

mean = (24.90 + 24.95 + 24.85) ÷ 3

mean = 74.70 ÷ 3

24.90 cm^3

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4 Chloe's titration results are shown in the table.

	Rough	1	2	3
Final reading in cm^3	26.10	26.65	26.10	27.75
Initial reading in cm^3	0.00	1.20	0.45	2.30

Concordant results are within 0.10 cm^3 of each other.

a. Calculate the titre for titration 2.

b. Calculate the mean titre from the concordant results.

(3 marks)

a)

Titre = final reading − initial reading

titre 2 = 26.10 − 0.45

25.65 cm^3

b)

titre 1 = 26.65 − 1.20 = 25.45 cm^3

titre 3 = 27.75 − 2.30 = 25.45 cm^3

Leave out the rough titre and 25.65 (not concordant)

mean = (25.45 + 25.45) ÷ 2

25.45 cm^3

5 **Higher tier**

A pipette delivers 25.0 cm^3 of sodium hydroxide solution into a conical flask. The concentration of the sodium hydroxide solution is 0.100 mol/dm^3.

Calculate the number of moles of sodium hydroxide in the flask.

(2 marks)

Change cm^3 to dm^3: divide by 1000

25.0 cm^3 = 25.0 ÷ 1000 = 0.0250 dm^3

Moles = concentration × volume

moles = 0.100 × 0.0250

0.00250 mol

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6 **Higher tier**

Dev's mean titre is 22.40 cm^3 of hydrochloric acid. The concentration of the acid is 0.150 mol/dm^3.

Calculate the number of moles of hydrochloric acid in the mean titre. (2 marks)

Change cm^3 to dm^3: divide by 1000

$22.40\ cm^3 = 22.40 \div 1000 = 0.02240\ dm^3$

Moles = concentration × volume

moles = 0.150 × 0.02240

0.00336 mol

7 **Higher tier**

A quality-control chemist at a vinegar factory dilutes a sample of vinegar ten times with water. A 20.0 cm^3 portion of the diluted solution contains 0.00180 mol of ethanoic acid.

Calculate the concentration of ethanoic acid in the diluted solution in mol/dm^3. (2 marks)

Change cm^3 to dm^3: divide by 1000

$20.0\ cm^3 = 20.0 \div 1000 = 0.0200\ dm^3$

Concentration = moles ÷ volume

concentration = 0.00180 ÷ 0.0200

0.0900 mol/dm^3

8 **Higher tier**

Mrs Adeyemi predicts that 0.00450 mol of nitric acid will be needed to neutralise the alkali in a flask. The nitric acid has a concentration of 0.200 mol/dm^3.

Calculate the volume of nitric acid needed, in cm^3. (3 marks)

Concentration = moles ÷ volume

0.200 = 0.00450 ÷ volume

Rearrange: volume = moles ÷ concentration

volume = 0.00450 ÷ 0.200

volume = 0.0225 dm^3

Change dm^3 to cm^3: multiply by 1000

volume = 0.0225 × 1000

22.5 cm^3

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9 **Higher tier**

A bottle of dilute hydrochloric acid, HCl, is labelled 7.30 g/dm^3.

Relative atomic masses (A_r): H = 1, Cl = 35.5

Calculate the concentration of the acid in mol/dm^3. (3 marks)

Relative formula mass of HCl

$M_r = 1 + 35.5 = 36.5$

1 dm^3 of the acid holds 7.30 g of HCl. Moles = mass ÷ M_r

moles in 1 dm^3 = 7.30 ÷ 36.5 = 0.200 mol

Concentration = moles ÷ volume

concentration = 0.200 ÷ 1

0.200 mol/dm^3

10 **Higher tier**

Tobi titrates 25.0 cm^3 of sodium hydroxide solution with hydrochloric acid of concentration 0.120 mol/dm^3. The mean titre is 21.60 cm^3.

$NaOH + HCl \rightarrow NaCl + H_2O$

Calculate the concentration of the sodium hydroxide solution in mol/dm^3.

Give your answer to 3 significant figures. Show your working. (4 marks)

Change cm^3 to dm^3: divide by 1000

21.60 cm^3 = 0.02160 dm^3

Moles of HCl = concentration x volume

moles HCl = 0.120 x 0.02160 = 0.002592 mol

1 NaOH reacts with 1 HCl

moles NaOH = 0.002592 mol

25.0 cm^3 = 0.0250 dm^3

Concentration = moles ÷ volume

concentration = 0.002592 ÷ 0.0250

concentration = 0.10368 mol/dm^3

0.104 mol/dm^3

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11 **Higher tier**

Priya puts 25.0 cm^3 of 0.150 mol/dm^3 sodium hydroxide solution in a conical flask. She titrates it with sulfuric acid from a burette.

Titration	Rough	1	2	3
Titre in cm^3	19.20	18.60	19.05	18.70

Concordant results are within 0.10 cm^3 of each other.

$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

a. Calculate the mean titre from the concordant results.

b. Calculate the concentration of the sulfuric acid in mol/dm^3. Give your answer to 3 significant figures. Show your working.

(5 marks)

a)

Leave out the rough titre and 19.05 (not concordant)

mean = (18.60 + 18.70) ÷ 2

18.65 cm^3

b)

Change cm^3 to dm^3: divide by 1000

25.0 cm^3 = 0.0250 dm^3

Moles of NaOH = concentration × volume

moles NaOH = 0.150 × 0.0250 = 0.00375 mol

1 H_2SO_4 reacts with 2 NaOH, so halve

moles H_2SO_4 = 0.00375 ÷ 2 = 0.001875 mol

18.65 cm^3 = 0.01865 dm^3

Concentration = moles ÷ volume

concentration = 0.001875 ÷ 0.01865

concentration = 0.10053... mol/dm^3

0.101 mol/dm^3

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12 **Higher tier**

A water treatment works checks a potassium hydroxide solution. A chemist titrates 25.0 cm^3 of the solution with nitric acid of concentration 0.0800 mol/dm^3.

- Rough titre: 24.30 cm^3
- Concordant titres: 23.70 cm^3 and 23.80 cm^3

$KOH + HNO_3 \rightarrow KNO_3 + H_2O$

Relative atomic masses (A_r): H = 1, O = 16, K = 39

a. Calculate the concentration of the potassium hydroxide solution in mol/dm^3.

b. Calculate the concentration of the potassium hydroxide solution in g/dm^3. Give your answer to 2 significant figures. Show your working.

(5 marks)

a)

Use the concordant titres only, not the rough titre

mean titre = (23.70 + 23.80) ÷ 2 = 23.75 cm^3

Change cm^3 to dm^3: divide by 1000

23.75 cm^3 = 0.02375 dm^3

Moles of HNO3 = concentration x volume

moles HNO3 = 0.0800 x 0.02375 = 0.0019 mol

1 KOH reacts with 1 HNO3

moles KOH = 0.0019 mol

25.0 cm^3 = 0.0250 dm^3

Concentration = moles ÷ volume

concentration = 0.0019 ÷ 0.0250

0.076 mol/dm^3

b)

Mr of KOH = 39 + 16 + 1 = 56

Mass in 1 dm^3 = moles x Mr

concentration = 0.076 x 56

concentration = 4.256 g/dm^3

4.3 g/dm^3

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