Back titration

AQA 7405 · Full A-level

Show your working where needed. Check the worked answers when you finish.

Name _____ Date _____

1. Limestone purity

Only $CaCO_3$ in a 0.500 g sample reacts with 50.0 cm^3 of excess 0.200 mol dm^{-3} HCl. Leftover HCl needs 20.00 cm^3 of 0.100 mol dm^{-3} NaOH. Find the mass percentage of $CaCO_3$ (M_r = 100.09). One mole $CaCO_3$ uses two moles HCl.

2. Magnesium oxide content

Only MgO in a 1.00 g sample reacts with 50.0 cm^3 of excess 1.00 mol dm^{-3} HCl. Make up to 250.0 cm^3. A 25.0 cm^3 portion requires 12.80 cm^3 of 0.100 mol dm^{-3} NaOH. Find the mass percentage of MgO (M_r = 40.31). One mole MgO uses two moles HCl.

3. Calcium carbonate in an antacid

Three antacid tablets (mean mass 1.200 g) contain $CaCO_3$ and inert material. Add 75.0 cm^3 of excess 0.500 mol dm^{-3} HCl and make up to 250.0 cm^3. A 25.0 cm^3 portion needs 10.50 cm^3 of 0.100 mol dm^{-3} NaOH. For each mole of $CaCO_3$, 2 mol HCl react. Find the mean mass of $CaCO_3$ per tablet in mg and its mass percentage (M_r = 100.09).

Scan to try fresh questions online

Try a core or harder question. Use clues and worked answers.

chemistryhelp.co.uk/worksheets/aqa-back-titration

Back titration

AQA 7405 · Full A-level

4. Identify a Group 2 metal

0.800 g of MCO_3 reacts with 50.0 cm^3 of excess 0.500 mol dm^{-3} HCl. Leftover acid needs 30.05 cm^3 of 0.300 mol dm^{-3} NaOH. One mole MCO_3 uses two moles HCl. Find $M_r(MCO_3)$ and identify M. A_r: Mg 24.31, Ca 40.08, Sr 87.62, Ba 137.33, C 12.01, O 16.00.

5. Concentration of a cleaner

Only Na_2CO_3 reacts in 25.0 cm^3 of cleaner. Add 50.0 cm^3 of excess 0.300 mol dm^{-3} HCl. The rest needs 25.00 cm^3 of 0.400 mol dm^{-3} NaOH. One mole Na_2CO_3 uses two moles HCl. Find the original concentration in mol dm^{-3} and g dm^{-3} (M_r = 105.99).

6. Aspirin in tablet powder

Heat 0.600 g tablet powder with 50.0 cm^3 of excess 0.200 mol dm^{-3} NaOH. Only aspirin reacts and it consumes two moles NaOH per mole of aspirin. Leftover NaOH needs 20.00 cm^3 of 0.200 mol dm^{-3} HCl. Find the mass percentage of aspirin (M_r = 180.16).

Scan to try fresh questions online

Try a core or harder question. Use clues and worked answers.

chemistryhelp.co.uk/worksheets/aqa-back-titration

Back titration

AQA 7405 · Full A-level

7. Purity from a redox titration

0.800 g of impure Na_2SO_3 reacts with 50.0 cm^3 of excess 0.100 mol dm^{-3} I_2. Leftover I_2 takes 10.00 cm^3 of 0.100 mol dm^{-3} thiosulfate. Na_2SO_3 reacts 1:1 with I_2, which reacts 1:2 with thiosulfate. Find the mass percentage of Na_2SO_3 (M_r = 126.04).

8. Hydrogen peroxide by redox titration

25.0 cm^3 H_2O_2 reacts with 25.0 cm^3 of excess acidified 0.0400 mol dm^{-3} MnO_4^-. The rest needs 20.00 cm^3 of 0.100 mol dm^{-3} Fe^{2+}. MnO_4^- reacts 2:5 with H_2O_2 and 1:5 with Fe^{2+}. Find the H_2O_2 concentration in mol dm^{-3} and g dm^{-3} (M_r = 34.0).

9. Extra challenge · Two measurements in an antacid analysis

In 1.260 g antacid powder, only $CaCO_3$ reacts with the 0.0600 mol HCl added. Dilute the reacted mixture to 250.0 cm^3. For 25.0 cm^3 portions, titres are 24.10, 24.20 and 24.85 cm^3 of 0.200 mol dm^{-3} NaOH. Average titres within 0.10 cm^3. Find the mass percentage $CaCO_3$ (M_r = 100.09). Explain the effect if residual water diluted the NaOH, but the calculation used its stated concentration.

Scan to try fresh questions online

Try a core or harder question. Use clues and worked answers.

chemistryhelp.co.uk/worksheets/aqa-back-titration

Worked answers

Back titration · AQA 7405 · Full A-level

1. Limestone purity

The flask initially contains 0.0500 × 0.200 = 0.0100 mol HCl. From the titration, 0.02000 × 0.100 = 0.00200 mol remains.

0.0100 − 0.00200 = 0.00800 mol HCl reacted with the sample. This corresponds to 0.00400 mol $CaCO_3$.

Mass of $CaCO_3$ = 0.00400 × 100.09 = 0.40036 g. Percentage by mass = (0.40036 ÷ 0.500) × 100 = 80.1%.

2. Magnesium oxide content

Initially there is 0.0500 mol HCl. One portion contains 0.01280 × 0.100 = 0.001280 mol HCl, so the whole flask contains 0.01280 mol unreacted HCl.

0.0500 − 0.01280 = 0.03720 mol HCl reacted. The 2:1 acid-to-oxide ratio gives 0.01860 mol MgO.

Mass of MgO = 0.01860 × 40.31 = 0.749766 g. The percentage is 75.0% to three significant figures.

3. Calcium carbonate in an antacid

Initial HCl = 0.03750 mol. The portion contains 0.01050 × 0.100 = 0.001050 mol excess HCl. The full flask therefore contains 0.01050 mol excess HCl.

HCl reacting with $CaCO_3$ = 0.03750 − 0.01050 = 0.02700 mol. The carbonate amount is 0.01350 mol, or 1.351215 g in all three tablets.

Mean = (1.351215 ÷ 3) × 1000 = 4.50×10^2 mg to three significant figures. The percentage is (1.351215 ÷ 3.600) × 100 = 37.5%.

Scan to try fresh questions online

Try a core or harder question. Use clues and worked answers.

chemistryhelp.co.uk/worksheets/aqa-back-titration

Worked answers

Back titration · AQA 7405 · Full A-level

4. Identify a Group 2 metal

HCl added = 0.02500 mol and HCl left = 0.03005 × 0.300 = 0.009015 mol. The acid that reacted is 0.015985 mol.

The carbonate amount is half of this, 0.0079925 mol. $M_r(MCO_3)$ = 0.800 ÷ 0.0079925 = 100.1…

Subtract 12.01 + 3 × 16.00 to estimate A_r(M) at 40.1. This matches calcium most closely.

5. Concentration of a cleaner

HCl added = 0.0150 mol. Remaining HCl = 0.0100 mol. The Na_2CO_3 used up 0.00500 mol of HCl.

The equation gives 0.00250 mol Na_2CO_3 in 25.0 cm^3. The molar concentration is 0.00250 ÷ 0.0250 = 0.100 mol dm^{-3}.

Mass concentration = 0.100 × 105.99 = 10.6 g dm^{-3}.

6. Aspirin in tablet powder

NaOH added = 0.01000 mol. The HCl neutralises 0.004000 mol of leftover NaOH. Therefore 0.006000 mol NaOH reacted with aspirin.

From the 2:1 ratio, n(aspirin) = 0.003000 mol. Its mass is 0.003000 × 180.16 = 0.54048 g.

Percentage by mass = (0.54048 ÷ 0.600) × 100 = 90.1%.

Scan to try fresh questions online

Try a core or harder question. Use clues and worked answers.

chemistryhelp.co.uk/worksheets/aqa-back-titration

Worked answers

Back titration · AQA 7405 · Full A-level

7. Purity from a redox titration

Initial I_2 = 0.00500 mol. Thiosulfate used = 0.00100 mol. The second equation shows that 0.000500 mol I_2 remained.

The sulfite used 0.00500 − 0.000500 = 0.00450 mol I_2. From the first equation the original sample contained 0.00450 mol Na_2SO_3.

The mass of Na_2SO_3 is 0.00450 × 126.04 = 0.56718 g, giving (0.56718 ÷ 0.800) × 100 = 70.9%.

8. Hydrogen peroxide by redox titration

MnO_4^- added = 0.00100 mol. The titre contains 0.00200 mol Fe^{2+}, equivalent to 0.000400 mol unreacted MnO_4^-.

MnO_4^- reacting with the peroxide = 0.000600 mol. The first equation gives 0.000600 × (5 ÷ 2) = 0.00150 mol H_2O_2 in 25.0 cm^3.

Concentration = 0.00150 ÷ 0.0250 = 0.0600 mol dm^{-3}. Mass concentration = 0.0600 × 34.0 = 2.04 g dm^{-3}.

9. Extra challenge · Two measurements in an antacid analysis

The chosen titres are 24.10 and 24.20 cm^3. Mean = 24.15 cm^3. The remaining HCl in the flask is 10 × 0.02415 × 0.200 = 0.04830 mol. The $CaCO_3$ reacted with 0.0600 − 0.04830 = 0.01170 mol HCl.

$CaCO_3$ uses two HCl per formula unit. The amount is 0.00585 mol and the percentage is 100 × 0.00585 × 100.09/1.260 = 46.5%.

Diluted NaOH gives a larger titre for the same remaining HCl. Using the stated concentration overstates the remaining acid and understates the reacted acid, so the calculated $CaCO_3$ percentage is too low.

Scan to try fresh questions online

Try a core or harder question. Use clues and worked answers.

chemistryhelp.co.uk/worksheets/aqa-back-titration