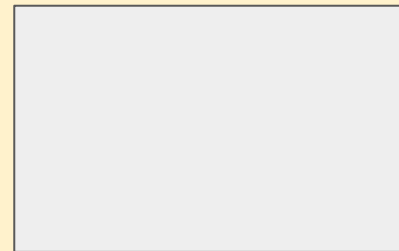


Back Titrations

[Cedarlearning.org](https://cedarlearning.org)

We make tricky chemistry topics simple



Game plan

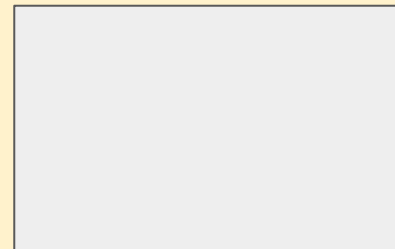
1. Review titration calculation
2. Explain what back titrations are and how they're used
3. Worked example of a back titration

What is a back titration?

In a simple titration we find an unknown concentration by comparing a known concentration and volume with an unknown.

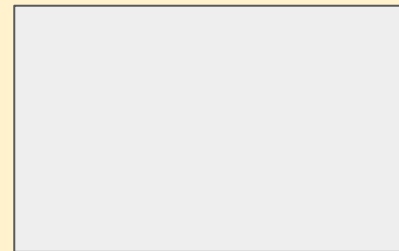
For example:

We could use a titration to find the concentration of an unknown solution of NaOH by reacting it with a **known** concentration of HCl .



Worked example

A student is given an unknown concentration of Barium Hydroxide and is asked to find the concentration. The Student finds that the mean average titre with a standard solution of 1mol/dm^3 HCl is 25cm^3 against 100ml of this unknown solution.

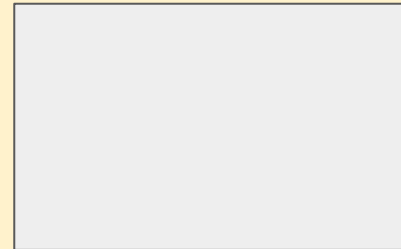


Worked example

A student is given an unknown concentration of Barium Hydroxide and is asked to find the concentration. The Student finds that the mean average titre with a standard solution of 1mol/dm^3 HCl is 25cm^3 against 100ml of this unknown solution.

1. Balance the equation

Formula for Barium hydroxide?



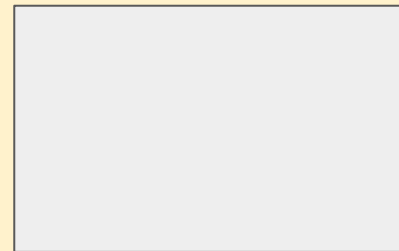
Worked example

A student is given an unknown concentration of Barium Hydroxide and is asked to find the concentration. The Student finds that the mean average titre with a standard solution of 1mol/dm^3 HCl is 25cm^3 against 100ml of this unknown solution.

1. Balance the equation

Formula for Barium hydroxide?

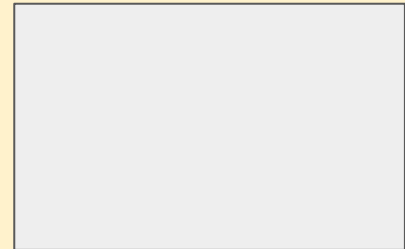
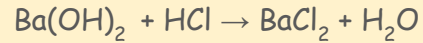
Barium is in group 2 so will form a $2+$ ion. The Hydroxide ion is OH^- . So for the compound to be neutral we need twice the hydroxides for each Barium ion.



Worked example

A student is given an unknown concentration of Barium Hydroxide and is asked to find the concentration. The Student finds that the mean average titre with a standard solution of 1mol/dm^3 HCl is 25cm^3 against 100ml of this unknown solution.

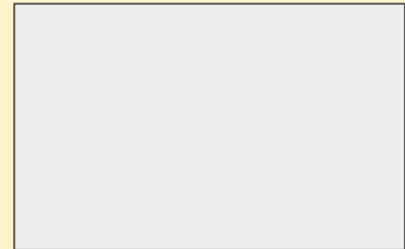
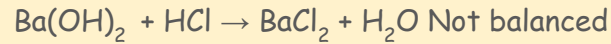
1. Balance the equation



Worked example

A student is given an unknown concentration of Barium Hydroxide and is asked to find the concentration. The Student finds that the mean average titre with a standard solution of 1mol/dm^3 HCl is 25cm^3 against 100ml of this unknown solution.

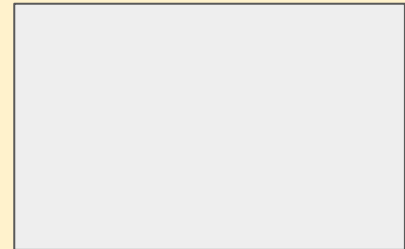
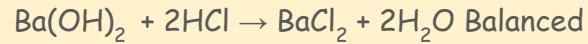
1. Balance the equation



Worked example

A student is given an unknown concentration of Barium Hydroxide and is asked to find the concentration. The Student finds that the mean average titre with a standard solution of 1mol/dm^3 HCl is 25cm^3 against 100ml of this unknown solution.

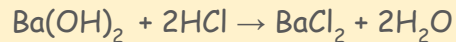
1. Balance the equation



Worked example

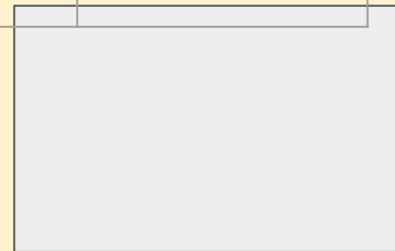
A student is given an unknown concentration of Barium Hydroxide and is asked to find the concentration. The Student finds that the mean average titre with a standard solution of 1mol/dm^3 HCl is 25cm^3 against 100ml of this unknown solution.

1. Balance the equation



2. Enter the values into this table (take care with units!)

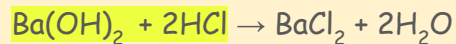
| | | |
|-------------------------------------|-------------------|-----|
| Substance | Ba(OH)_2 | HCl |
| Ratio | | |
| Amount(mol) | | |
| Volume(dm^3) | | |
| Concentration (mol/dm^3) | | |



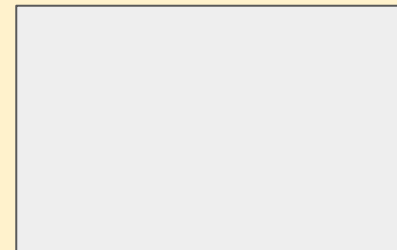
Worked example

A student is given an unknown concentration of Barium Hydroxide and is asked to find the concentration. The Student finds that the mean average titre with a standard solution of 1mol/dm^3 HCl is 25cm^3 against 100ml of this unknown solution.

1. Balance the equation



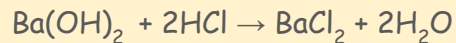
| Substance | Ba(OH)_2 | HCl |
|-------------------------------------|-------------------|-----|
| Ratio | 1 | 2 |
| Amount(mol) | | |
| Volume(dm^3) | | |
| Concentration (mol/dm^3) | | |



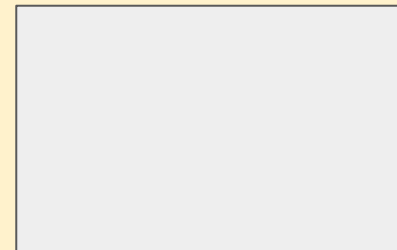
Worked example

A student is given an unknown concentration of Barium Hydroxide and is asked to find the concentration. The Student finds that the mean average titre with a standard solution of 1mol/dm^3 HCl is 25cm^3 against 100ml of this unknown solution.

1. Balance the equation



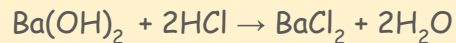
| | | |
|-------------------------------------|-------------------|-----|
| Substance | Ba(OH)_2 | HCl |
| Ratio | | |
| Amount(mol) | | |
| Volume(dm^3) | | |
| Concentration (mol/dm^3) | | |



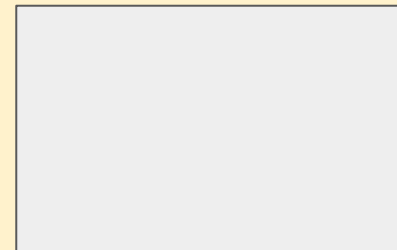
Worked example

A student is given an unknown concentration of Barium Hydroxide and is asked to find the concentration. The Student finds that the mean average titre with a standard solution of 1mol/dm^3 HCl is **25cm³** against **100ml** of this unknown solution.

1. Balance the equation



| | | |
|--------------------------------------|-------------------|-----|
| Substance | Ba(OH)_2 | HCl |
| Ratio | | |
| Amount(mol) | | |
| Volume(dm³) | | |
| Concentration (mol/dm ³) | | |



Conversion

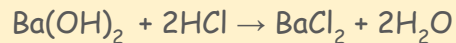
$$1000\text{ml}=1000\text{cm}^3=1\text{dm}^3=1\text{L}$$

So, to convert from ml or cm^3 we must divide by 1000.

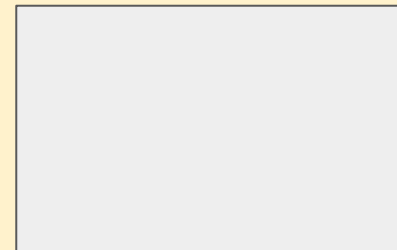
Worked example

A student is given an unknown concentration of Barium Hydroxide and is asked to find the concentration. The Student finds that the mean average titre with a standard solution of 1mol/dm^3 HCl is **25cm³** against **100ml** of this unknown solution.

1. Balance the equation



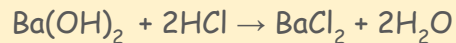
| | | |
|--------------------------------------|-------------------|---------|
| Substance | Ba(OH)_2 | HCl |
| Ratio | | |
| Amount(mol) | | |
| Volume(dm³) | 100/1000 | 25/1000 |
| Concentration (mol/dm ³) | | |



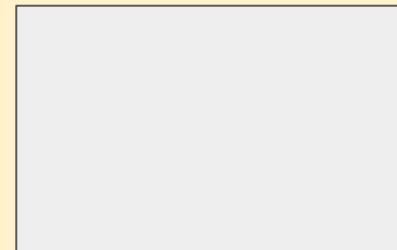
Worked example

A student is given an unknown concentration of Barium Hydroxide and is asked to find the concentration. The Student finds that the mean average titre with a standard solution of 1 mol/dm^3 HCl is 25cm^3 against 100ml of this unknown solution.

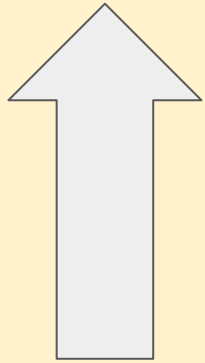
1. Balance the equation



| | | |
|--|-------------------|-----|
| Substance | Ba(OH)_2 | HCl |
| Ratio | | |
| Amount(mol) | | |
| Volume(dm^3) | | |
| Concentration (mol/dm^3) | | 1 |



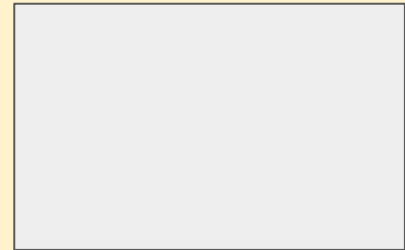
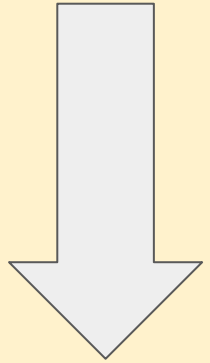
Why use a table?



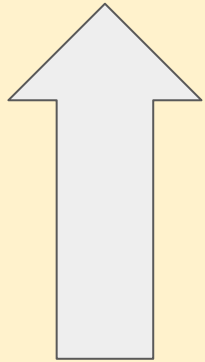
Times up!

| | | |
|---|---------------------|-------|
| Substance | Ba(OH) ₂ | HCl |
| Ratio | 1 | 2 |
| Amount(mol) | | |
| Volume(dm ³) | 0.1 | 0.025 |
| Concentration (mol/dm ³) | | 1 |

Divide down!



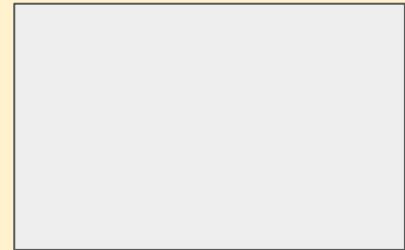
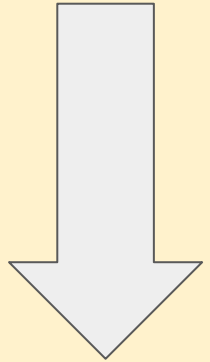
Why use a table?



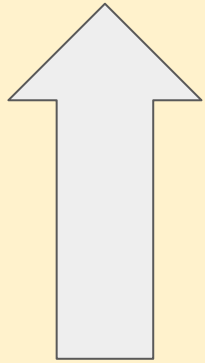
Times up!

| | | |
|---|---------------------|-------|
| Substance | Ba(OH) ₂ | HCl |
| Ratio | 1 | 2 |
| Amount(mol) | | 0.025 |
| Volume(dm ³) | 0.1 | 0.025 |
| Concentration (mol/dm ³) | | 1 |

Divide down!



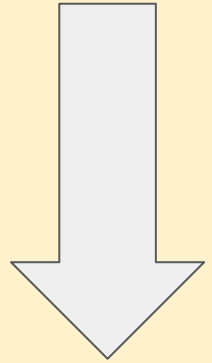
Why use a table?



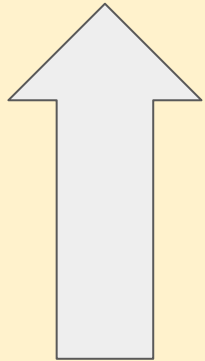
Times up!

| | | |
|---|--------------------------|-------|
| Substance | $\text{Ba}(\text{OH})_2$ | HCl |
| Ratio | 1 | 2 |
| Amount(mol) | 0.025/2 | 0.025 |
| Volume(dm ³) | 0.1 | 0.025 |
| Concentration (mol/dm ³) | | 1 |

Divide down!



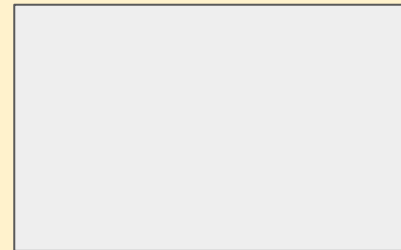
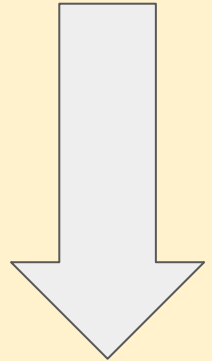
Why use a table?



Times up!

| | | |
|--------------------------------------|---------------------|-------|
| Substance | Ba(OH) ₂ | HCl |
| Ratio | 1 | 2 |
| Amount(mol) | 0.0125 | 0.025 |
| Volume(dm ³) | 0.1 | 0.025 |
| Concentration (mol/dm ³) | 0.125 | 1 |

Divide down!



What is a back titration?

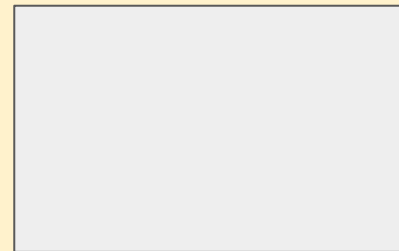
In a simple titration we find an unknown concentration by comparing a known concentration and volume with an unknown.

But what if we have a solid?

What if we're testing something that is volatile (becomes a gas easily)?

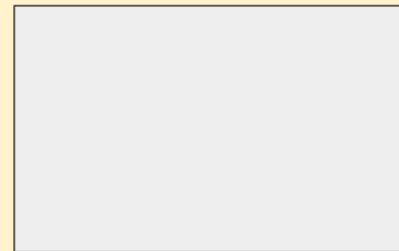
What if a direct reaction is incredibly slow?

What if we have a mixture?



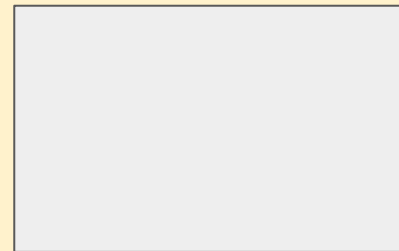
Back titrations use three/four steps

1. Add *excess reagent*
2. Let it react with analyte
3. Dilute (for repeats)
4. Titrate the leftover reagent



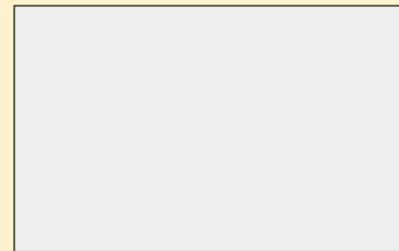
Back titrations use three/four steps

1. Add *excess reagent*
2. Let it react with analyte
3. Dilute (for repeats)
4. Titrate the leftover reagent



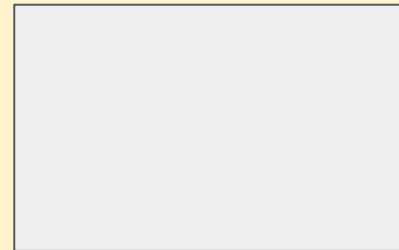
Back titrations use three/four steps

1. Add *excess reagent*
2. Let it react with analyte
3. Dilute (for repeats)
4. Titrate the leftover reagent



Back titrations use three/four steps

1. Add *excess reagent*
2. Let it react with analyte
3. Dilute (for repeats)
4. Titrate the leftover reagent

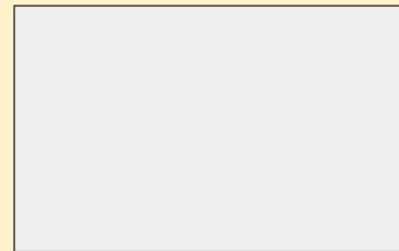


Worked example

A student investigates the mass of calcium carbonate in an indigestion tablet by titration.

Three indigestion tablets were reacted in a beaker containing 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid.

How do we know this will be a back titration problem?



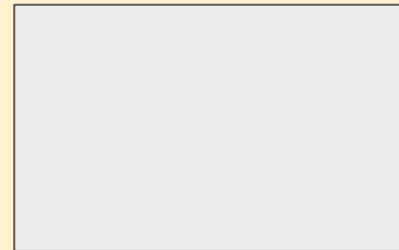
Worked example

A student investigates the mass of calcium carbonate in an indigestion tablet by titration.

Three indigestion tablets were reacted in a beaker containing 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid.

How do we know this will be a back titration problem?

We are testing a solid(insoluble) using titration.

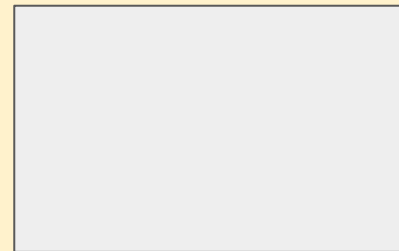


Worked example

A student investigates the mass of calcium carbonate in an indigestion tablet by titration.

Three indigestion tablets were reacted in a beaker containing 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid.

After the reaction the student makes a 250 cm^3 standard solution with the leftover acid.

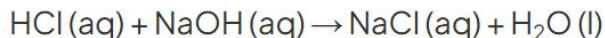


Worked example

A student investigates the mass of calcium carbonate in an indigestion tablet by titration.

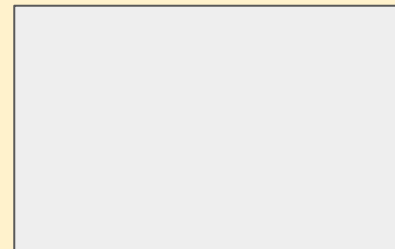
Three indigestion tablets were reacted in a beaker containing 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid.

The student titrates 25.0 cm^3 of the standard solution from part (a) with 0.10 mol dm^{-3} sodium hydroxide solution. The average titre was found to be 24.90 cm^3 .



Calculate the mass of calcium carbonate ($M_r = 100.1$), in mg, present in one indigestion tablet. Give your answer to the appropriate number of significant figures.

After the reaction the student makes a 250 cm^3 standard solution with the leftover acid.

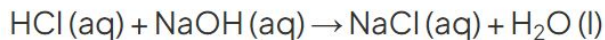


Detective hats on let's find clues

A student investigates the mass of calcium carbonate in an indigestion tablet by titration.

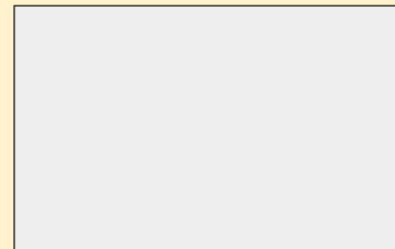
Three indigestion tablets were reacted in a beaker containing 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid.

The student titrates 25.0 cm^3 of the standard solution from part (a) with 0.10 mol dm^{-3} sodium hydroxide solution. The average titre was found to be 24.90 cm^3 .



Calculate the mass of calcium carbonate ($M_r = 100.1$), in mg, present in one indigestion tablet. Give your answer to the appropriate number of significant figures.

After the reaction the student makes a 250 cm^3 standard solution with the leftover acid.

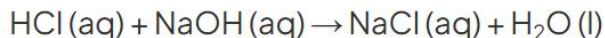


Detective hats on let's find clues

A student investigates the mass of calcium carbonate in an indigestion tablet by titration.

Three indigestion tablets were reacted in a beaker containing 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid.

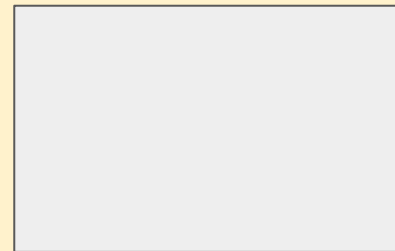
The student titrates 25.0 cm^3 of the standard solution from part (a) with 0.10 mol dm^{-3} sodium hydroxide solution. The average titre was found to be 24.90 cm^3 .



Calculate the mass of calcium carbonate ($M_r = 100.1$), in mg, present in one indigestion tablet. Give your answer to the appropriate number of significant figures.

After the reaction the student makes a 250 cm^3 standard solution with the leftover acid.

Three tablets but we want to know the mass in 1.

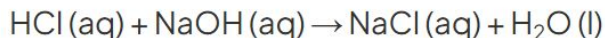


Detective hats on let's find clues

A student investigates the mass of calcium carbonate in an indigestion tablet by titration.

Three indigestion tablets were reacted in a beaker containing 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid.

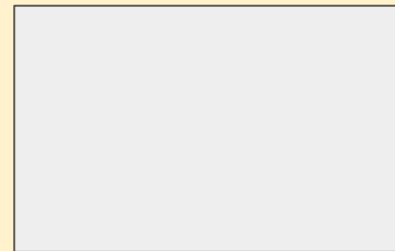
The student titrates 25.0 cm^3 of the standard solution from part (a) with 0.10 mol dm^{-3} sodium hydroxide solution. The average titre was found to be 24.90 cm^3 .



Calculate the mass of calcium carbonate ($M_r = 100.1$), in mg, present in one indigestion tablet. Give your answer to the appropriate number of significant figures.

After the reaction the student makes a 250 cm^3 standard solution with the leftover acid.

The total volume and initial concentration of HCL before the reaction

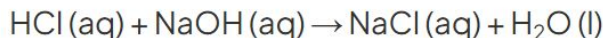


Detective hats on let's find clues

A student investigates the mass of calcium carbonate in an indigestion tablet by titration.

Three indigestion tablets were reacted in a beaker containing 50.0 cm³ of 1.00 mol dm⁻³ hydrochloric acid.

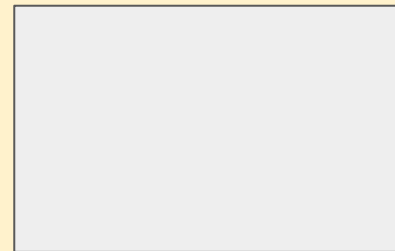
The student titrates 25.0 cm³ of the standard solution from part (a) with 0.10 mol dm⁻³ sodium hydroxide solution. The average titre was found to be 24.90 cm³.



Calculate the mass of calcium carbonate ($M_r = 100.1$), in mg, present in one indigestion tablet. Give your answer to the appropriate number of significant figures.

After the reaction the student makes a 250 cm³ standard solution with the leftover acid.

We're using 25 ml out of 250 ml so dilution factor of 10.

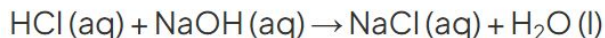


Detective hats on let's find clues

A student investigates the mass of calcium carbonate in an indigestion tablet by titration.

Three indigestion tablets were reacted in a beaker containing 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid.

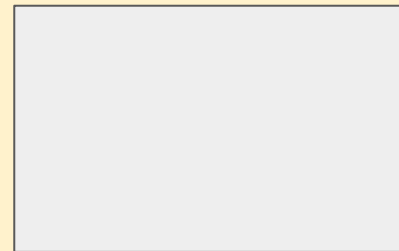
The student titrates 25.0 cm^3 of the standard solution from part (a) with 0.10 mol dm^{-3} sodium hydroxide solution. The average titre was found to be 24.90 cm^3 .



Calculate the mass of calcium carbonate ($M_r = 100.1$), in mg, present in one indigestion tablet. Give your answer to the appropriate number of significant figures.

After the reaction the student makes a 250 cm^3 standard solution with the leftover acid.

The concentration of $\text{NaOH} = 0.1 \text{ M}$

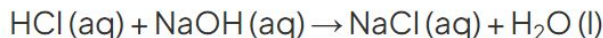


Detective hats on let's find clues

A student investigates the mass of calcium carbonate in an indigestion tablet by titration.

Three indigestion tablets were reacted in a beaker containing 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid.

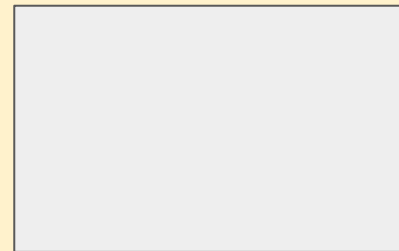
The student titrates 25.0 cm^3 of the standard solution from part (a) with 0.10 mol dm^{-3} sodium hydroxide solution. The average titre was found to be 24.90 cm^3 .



Calculate the mass of calcium carbonate ($M_r = 100.1$), in mg, present in one indigestion tablet. Give your answer to the appropriate number of significant figures.

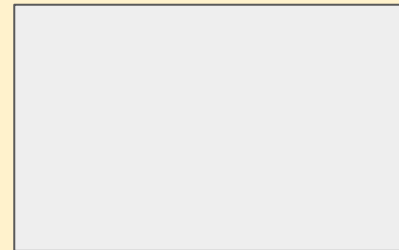
After the reaction the student makes a 250 cm^3 standard solution with the leftover acid.

The volume of NaOH used = 24.90 ml



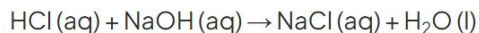
Back titrations use three/four steps

1. Add *excess reagent*
2. Let it react with analyte
3. Dilute (for repeats)
4. Titrate the leftover reagent [Let's work backwards like the name suggests]



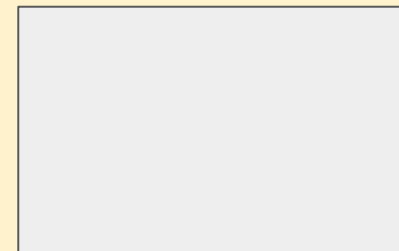
Step 1. Find the amount of acid in the diluted sample

The student titrates 25.0 cm³ of the standard solution from part (a) with 0.10 mol dm⁻³ sodium hydroxide solution. The average titre was found to be 24.90 cm³.



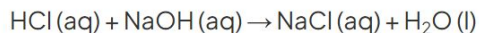
Calculate the mass of calcium carbonate ($M_r = 100.1$), in mg, present in one indigestion tablet. Give your answer to the appropriate number of significant figures.

| | | |
|--------------------------------------|--------|-------|
| Substance | NaOH | HCl |
| Ratio | 1 | 1 |
| Amount(mol) | | |
| Volume(dm ³) | 0.0249 | 0.025 |
| Concentration (mol/dm ³) | 0.1 | |



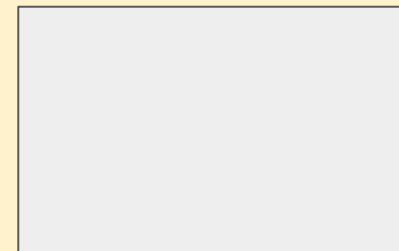
Step 1. Find the amount of acid in the diluted sample

The student titrates 25.0 cm³ of the standard solution from part (a) with 0.10 mol dm⁻³ sodium hydroxide solution. The average titre was found to be 24.90 cm³.



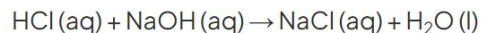
Calculate the mass of calcium carbonate ($M_r = 100.1$), in mg, present in one indigestion tablet. Give your answer to the appropriate number of significant figures.

| | | |
|--------------------------------------|---------|-------|
| Substance | NaOH | HCl |
| Ratio | 1 | 1 |
| Amount(mol) | 0.00249 | |
| Volume(dm ³) | 0.0249 | 0.025 |
| Concentration (mol/dm ³) | 0.1 | |



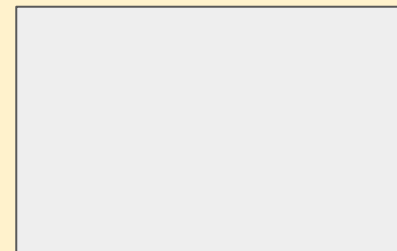
Step 1. Find the amount of acid in the diluted sample

The student titrates 25.0 cm³ of the standard solution from part (a) with 0.10 mol dm⁻³ sodium hydroxide solution. The average titre was found to be 24.90 cm³.



Calculate the mass of calcium carbonate ($M_r = 100.1$), in mg, present in one indigestion tablet. Give your answer to the appropriate number of significant figures.

| | | |
|--------------------------------------|---------|-------------------------------|
| Substance | NaOH | HCl |
| Ratio | 1 | 1 |
| Amount(mol) | 0.00249 | 0.00249 |
| Volume(dm ³) | 0.0249 | 0.025 |
| Concentration (mol/dm ³) | 0.1 | Doesn't matter don't need it. |



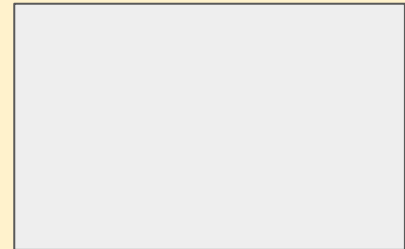
Step 2. How much was in the sample after the reaction?

The sample was diluted by a factor of 10.

There was 0.00249mol in the diluted sample.

$$0.00249\text{mol} \times 10 = 0.0249\text{mol}$$

This is what was left over after reacting with the solid.



Step 3. Find out how much was used

A student investigates the mass of calcium carbonate in an indigestion tablet by titration.

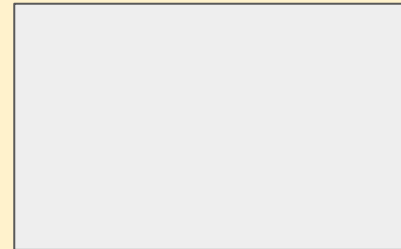
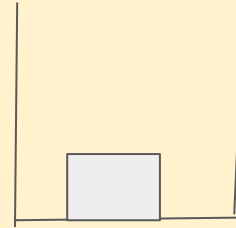
Three indigestion tablets were reacted in a beaker containing 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid.

$50 \text{ cm}^3 = 0.05 \text{ dm}^3$ [number of moles = Concentration * Volume (double check units!)]

$0.05 \text{ dm}^3 * 1.00 = 0.05 \text{ mol}$ of starting acid.

Acid used = starting acid - remaining acid

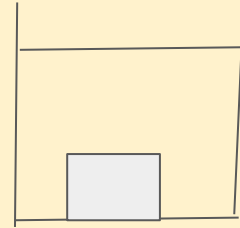
Acid used = $0.05 \text{ mol} - 0.0249 = 0.0251 \text{ mol}$ of acid was used.



Step 3. Find out how much was used

A student investigates the mass of calcium carbonate in an indigestion tablet by titration.

Three indigestion tablets were reacted in a beaker containing 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid.

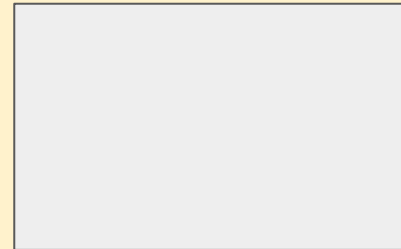


$50 \text{ cm}^3 = 0.05 \text{ dm}^3$ [number of moles = Concentration * Volume (double check units!)]

$0.05 \text{ dm}^3 * 1.00 = 0.05 \text{ mol}$ of starting acid.

Acid used = starting acid - remaining acid

Acid used = $0.05 \text{ mol} - 0.0249 = 0.0251 \text{ mol}$ of acid was used.



Step 3. Find out how much was used

A student investigates the mass of calcium carbonate in an indigestion tablet by titration.

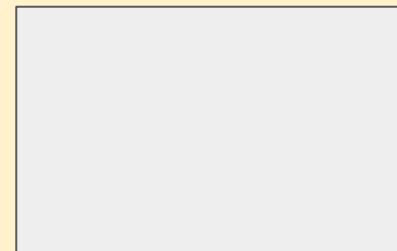
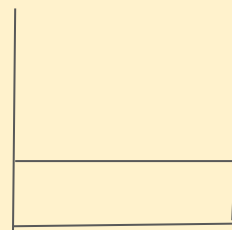
Three indigestion tablets were reacted in a beaker containing 50.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid.

$50 \text{ cm}^3 = 0.05 \text{ dm}^3$ [number of moles = Concentration * Volume (double check units!)]

$0.05 \text{ dm}^3 * 1.00 = 0.05 \text{ mol}$ of starting acid.

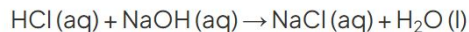
Acid used = starting acid - remaining acid

Acid used = $0.05 \text{ mol} - 0.0249 = 0.0251 \text{ mol}$ of acid was used.



Step 4. Compare to original reaction

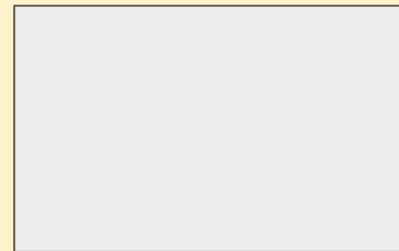
The student titrates 25.0 cm³ of the standard solution from part (a) with 0.10 mol dm⁻³ sodium hydroxide solution. The average titre was found to be 24.90 cm³.



Calculate the mass of calcium carbonate ($M_r = 100.1$), in mg, present in one indigestion tablet. Give your answer to the appropriate number of significant figures.

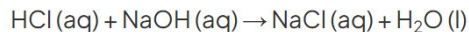
The equation tells us that for every 2mol of HCl we will use 1mol of CaCO₃. So half as much.

$$0.0251/2 = 0.01255 \text{ mol of CaCO}_3$$



The sneaky

The student titrates 25.0 cm³ of the standard solution from part (a) with 0.10 mol dm⁻³ sodium hydroxide solution. The average titre was found to be 24.90 cm³.



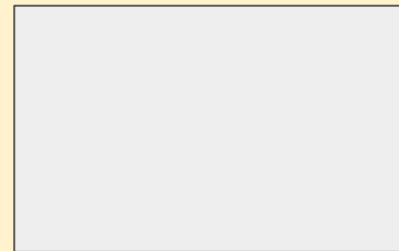
Calculate the mass of calcium carbonate ($M_r = 100.1$), in mg, present in one indigestion tablet. Give your answer to the appropriate number of significant figures.

But this is in 3 tablets.

$$0.0251/2 = 0.01255 \text{ mol of CaCO}_3.$$

To find out the amount in 1 we must divide by 3.

$$0.01255/3 = 0.00418333333 \text{ mol}$$



Last step and clean up

$$\text{Mass(g)} = \text{Number of moles} * M_r = 0.004183333333\text{mol} * 100.1$$

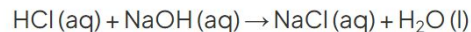
$$= 0.418751666666\text{g}$$

But the questions wants mg.

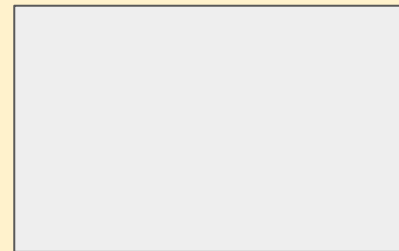
g → mg we times by 1000

418.8mg in one tablet. **OR 419mg(3sf)**

The student titrates 25.0 cm³ of the standard solution from part (a) with 0.10 mol dm⁻³ sodium hydroxide solution. The average titre was found to be 24.90 cm³.



Calculate the mass of calcium carbonate ($M_r = 100.1$), in mg, present in one indigestion tablet. Give your answer to the appropriate number of significant figures.



Back Titrations

[Cedarlearning.org](https://cedarlearning.org)

We make tricky chemistry topics simple

