WJEC (Wales) Chemistry A-level

SP 1.7c - Back Titration

Flashcards

What chemicals are required to carry out a back titration to determine the percentage of calcium carbonate in limestone?

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- Limestone chips
- 0.1 mol dm^{-3} NaOH solution
- 0.5 mol dm^{-3} HCl solution
- Phenolphthalein indicator

How can a back titration be carried out to determine the percentage of $CaCO_3$ in limestone?

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The known mass of limestone is reacted with an excess known volume of HCl. The excess HCl is then titrated with NaOH until neutralisation. Use this to calculate the volume of excess HCl. The amount of excess HCl can be subtracted from the volume of HCl added to the $CaCO_3$ to indicate how much reacted in the first reaction. Use this value with the reaction equation to calculate how many grams of $CaCO_3$ reacted in the first reaction. The mass of the $CaCO_3$ can then be compared to the original mass of limestone to determine the percentage of $CaCO_3$ in limestone.

Give the chemical equation for the reaction between $CaCO_3$ and HCl

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$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

Give the chemical equation for the reaction between HCl and NaOH

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$$HCl + NaOH \rightarrow NaCl + H_2O$$

Originally 25 cm^3 of excess 0.5 mol dm^{-3} HCl was added to limestone. 8 cm^3 of 0.1 mol dm^{-3} NaOH is required to neutralise the excess HCl. How much $CaCO_3$ was in the limestone?

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0.0008 mol NaOH (0.008 x 0.1) reacts with excess HCl in 1:1 ratio. So there is 0.0016 dm^3 of excess HCl (0.008 ÷ 0.5). Therefore, 0.0234 dm^3 HCl reacts with $CaCO_3$ in the first reaction (0.025 - 0.0016). This means 0.0117 mol of HCl (0.0234 x 0.5) reacted with $CaCO_3$ in a 2:1 ratio, so 0.00585 mol of $CaCO_3$ reacted. The Mr of $CaCO_3$ is 100.1 so 0.586 g of $CaCO_3$ was in the limestone (0.00585 x 100.1).

0.65 g of limestone powder was reacted with HCl in a back titration. 0.42 g of $CaCO_3$ was found to have reacted with the HCl. What is the percentage of $CaCO_3$ in the limestone?

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(0.42 ÷ 0.65) x 100 = 64.6% of $CaCO_3$ in the limestone

Describe a back titration experimental procedure to calculate percentage of calcium carbonate in limestone

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1. Grind the limestone chips into a fine powder.
2. Accurately weigh around 0.5 g of limestone powder and transfer to a conical flask.
3. Record the mass of limestone added.
4. Using a pipette, add 25 cm^3 HCl solution.
5. Stir the reaction mixture with a stirring rod whilst heating gently.
6. When the limestone has dissolved, cool to room temperature.
7. Add a few drops of phenolphthalein and titrate against the NaOH.
8. Record the volume of NaOH solution needed to neutralise the excess HCl solution and use this to calculate the percentage $CaCO_3$ in limestone.

Explain why the limestone chips are crushed into a fine powder before reacting with HCl

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Making the chips into a powder increases the surface area of the limestone reactant. This increases the rate of reaction because there are more exposed reactant particles - so more frequent successful collisions.

Explain why the HCl and limestone powder are heated

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Heating the reaction mixture increases the rate of reaction. This is because more of the reacting particles will have sufficient energy to react (activation energy) and the kinetic energy of the particles will be greater, meaning there will be more frequent collisions. Both of these effects lead to an increase in the number of successful reaction collisions.

Why must the HCl and limestone powder be heated *gently*?

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It is important that the mixture is only heated gently to prevent any of the solution evaporating. This ensures the measurements used in the calculations are as accurate as possible.

What apparatus is required to carry out a titration?

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- 50 cm^3 burette
- 25 cm^3 pipette and filler
- Conical flasks
- Funnel

What is a suitable indicator to use in a titration between HCl and NaOH?

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Phenolphthalein

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- Colourless in acid
- Pink in alkali

Phenolphthalein will change colour in the pH range 8.3-10.

What are the hazards associated with HCl, NaOH and phenolphthalein?

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HCl - irritant

NaOH - irritant

Phenolphthalein - flammable

What type of reaction takes place between HCl and NaOH?

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Neutralisation

Why should the burette be filled below eye level?

Why should the burette be filled below eye level?

The burette should be filled below eye level so that if any of the acid spills whilst being poured in, it will not splash into your face.

Why are titrations usually carried out on a white tile?

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The white tile allows the point of colour change to be easily identified.

How can you calculate how much NaOH was required to neutralise the excess HCl?

How can you calculate how much NaOH was required to neutralise the excess HCl?

Volume of NaOH =

Initial burette reading - final burette reading

Why is the HCl and limestone reaction mixture placed in a conical flask?

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During the titration, the conical flask allows the mixture to be swirled without losing any of the contents.

Why must the reaction mixture be swirled during the titration?

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Swirling ensures all the reacting particles collide and react. This helps to give a more accurate end point for the reaction.