

## Acid–base back titration

This resource accompanies the article **The essential guide to teaching quantitative chemistry** in *Education in Chemistry* which can be viewed at: [rsc.li/44KTIPQ](https://rsc.li/44KTIPQ).

Find the practical procedure in the student worksheet.

### Equipment

Learners can do this experiment individually or as a pair/small group. Each group will require:

- Two 100 ml conical flasks
- 25 ml or 50 ml pipette
- 10 ml pipette
- Pipette fillers sized to match the pipettes
- Mass balance measuring three decimal places (0.001 g)\*
- Burette
- Clamp and retort
- White tile
- Cotton wool
- Safety equipment: safety spectacles

\*If a mass balance measuring three decimal places is not available then use a mass balance measuring two decimal places (0.01 g). This will be less accurate though.


### Chemicals

- Hydrochloric acid solution, 1.00 mol dm<sup>-3</sup>
- Calcium carbonate chips – medium size – approx 1.00 g
- Sodium hydroxide, 0.400 mol dm<sup>-3</sup>
- Phenolphthalein indicator solution in dropper bottles

### Safety and hazards

- Read our standard health and safety guidance, available from [rsc.li/3IAmFA0](https://rsc.li/3IAmFA0) and carry out a risk assessment before running any live practical.
- Refer to SSERC/CLEAPSS Hazcards and recipe sheets.
- Hazard classification may vary depending on the supplier.

Chemical supplied for the practical	Preparation
Hydrochloric acid solution – $1.00 \text{ mol dm}^{-3}$ HCl (aq) Currently not classified as hazardous.	Dilute a solution of slightly higher concentration. Alternatively: Hydrochloric acid concentrated solution HCl (aq) MW= $36.46 \text{ g mol}^{-1}$ © Shutterstock <b>Danger</b> Causes severe skin burns and eye damage. May cause respiratory irritation. Wear splashproof goggles or a face shield and chemical resistant gloves. Work in a fume cupboard.
Sodium hydroxide solution – $0.40 \text{ mol dm}^{-3}$ NaOH (aq) Currently not classified as hazardous.	Sodium hydroxide solid NaOH (s) MW= $40.00 \text{ g mol}^{-1}$ © Shutterstock <b>Danger</b> Corrosive to eyes and skin. Wear splashproof goggles or a face shield and chemical resistant gloves. Avoid raising dust especially if the solid is a fine powder. Weigh in a fume cupboard (switched off) behind the sash for safety.
Calcium carbonate chips Currently not classified as hazardous.	N/A
Phenolphthalein indicator solution in IDA © Shutterstock <b>Danger</b> Highly flammable, suspected of causing genetic defects, may cause cancer.	Purchase ready made from suppliers or prepare a 0.1% solution in industrial denatured alcohol (IDA) by dissolving 1 g phenolphthalein solid in 600 ml IDA and topping up with distilled water to make a 1 l solution. IDA © Shutterstock

	<p><b>Danger</b></p> <p>Highly flammable liquid and vapour. Harmful if swallowed, may cause damage to organs and may cause serious eye irritation.</p> <p>Phenolphthalein solid</p> <p> © Shutterstock</p> <p><b>Danger</b></p> <p>Suspected of causing genetic defects, may cause cancer.</p> <p>Wear eye protection and chemical resistant gloves. Weigh the solid phenolphthalein in a fume cupboard (switched off) behind the sash for safety.</p>
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## Disposal

- The hydrochloric acid contains a very small amount of phenolphthalein indicator and it is neutralised by the excess of calcium carbonate, so you can dispose of the solution directly in the sink with plenty of water.
- Dilute any hydrochloric acid solution that you cannot recycle due to contamination down to  $0.1 \text{ mol dm}^{-3}$  and pour down a foul-water drain.
- Dilute any sodium hydroxide solution you cannot recycle due to contamination down to  $0.1 \text{ mol dm}^{-3}$  and pour down a foul-water drain.
- Use a sieve to retrieve any unreacted marble chips and dispose of as general waste.

## Additional information

- Try the practical beforehand, as the quality of calcium carbonate chips varies between suppliers and to check how the readability of the balances (two or three decimal places) will affect your results. Level the balances on the bench.
- Make the sodium hydroxide solution fresh for titration. Dispense it in plastic bottles with screw tops to avoid the formation of a white solid precipitate by reacting with atmospheric carbon dioxide.
- Keep the phenolphthalein solution in plastic dropper bottles with lids to avoid the formation of crystals. If dropper bottles are not available, decant from a large plastic bottle with a screw cap.