Hard water challenge

Download the PowerPoint presentation, teacher notes and student workbook that accompany this resource at rsc.li/3Pqq6Jz.

Read our health & safety guidance, available from [rsc.li/3IAmFA0](https://rsc.li/3IAmFA0), and carry out a risk assessment before running any live practical. Use the specific safety notes for the practicals included in this workshop to guide you.

Safety glasses should be supplied for all learners.

The safety equipment suggested is in line with CLEAPSS requirements. For non-hazardous substances, wearing lab coats can help to protect clothes. The safety rules might be different where you live so it is worth checking local and school guidance.

Methods for each practical are available in the student workbook.

Safety

Refer to SSERC/CLEAPSS Hazcards and recipe sheets.

Hazard classification may vary depending on supplier.

The equipment listed assumes a class size of 30 learners working in pairs or groups   
of three.

Acknowledgements

This resource was originally developed by Nottingham Trent University to support outreach work delivered as part of the Chemistry for All Project.

To find out more about the project, and get more resources to widen participation, visit our Outreach resources hub: [rsc.li/3CJX7M3](https://rsc.li/3CJX7M3).

Note: all hazard symbol images are © Shutterstock.

Activity 1: measuring calcium concentrations

Equipment (per group)

* 6 × boiling tubes
* 1 × boiling tube rack
* 5 cm3 measuring cylinder or plastic syringe
* 1 cm3 pipette
* Dropping pipette
* Permanent marker pen
* Graph paper
* Safety equipment: safety glasses

Preparation

* EDTA solution, 0.01 mol dm–3. (The solution must be at pH 8 for the solid to dissolve. Adjust the pH by adding sodium hydroxide pellets and check the pH using a pH meter or pH paper.)
* 30 cm3 buffer solution pH 10 per group (Buffer pH 10–can be purchased from a chemical supplier or made as follows:

To make 100 ml of buffer solution add 15.0 cm3 of ammonium chloride solution (0.20 mol dm–3) to 85.0 cm3 of ammonia solution (0.20 mol dm–3).

* Eriochrome-T-black indicator solution (made by dissolving 1.00 g of Eriochrome-T-black solid in 100 cm3 of ethanol)
* Calcium chloride solutions of five different concentrations of calcium: 100 ppm;   
  200 ppm; 300 ppm; 400 p ppm pm; 500 ppm (2 cm3 of each concentrationper group, per repeat) made by dissolving the following masses of solid CaCl2.6H2O in 1000 ml of distilled water:

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| --- | --- |
| **Concentration of calcium (ppm)** | **Mass of CaCl2..6H2O (g)** |
| 100 | 0.55 |
| 200 | 1.09 |
| 300 | 1.64 |
| 400 | 2.19 |
| 500 | 2.73 |

* Distilled water for cleaning pipettes and testing (2 cm3 per group, per repeat)

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| **Chemical supplied for the practical** | **Preparation** |
| EDTA – 0.01 mol dm–3  LiCl (aq)  Currently not classified as hazardous | EDTA, disodium salt, dihydrate solid  C10H14N2Na2O8.2H2O (s)  MW= 372.24 g mol–1  Irritant hazard warning symbol showing a red diamond containing an exclamation mark  WARNING  Harmful if swallowed  Causes skin irritation  Causes eye irritation  Sodium hydroxide solid  NaOH (s)  MW= 40.00 g mol–1  Corrosive hazard label showing two test tubes - one pouring liquid onto a surface which is reacting and the other is pouring liquid onto a hand which is reacting. The label corrosive is written below the red diamond  DANGER  Causes severe skin burns and eye damage |
| Buffer solution pH 10  (ammonia solution and ammonium chloride solution)  Currently not classified as hazardous | Ammonia (ammonium hydroxide) solution, 0.20 mol dm–3  NH3 (aq)  Currently not classified as hazardous but avoid breathing vapours  Ammonium chloride solution,  0.20 mol dm–3  NH4Cl (aq)  Currently not classified as hazardous |

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| **Chemical supplied for the practical** | **Preparation** |
| Calcium chloride solutions – up to 500 ppm of calcium  CaCl2 (aq)  Currently not classified as hazardous | Calcium chloride-6-water solid  CaCl2.6H2O (s)  MW= 219.08 g mol–1  Currently not classified as hazardous  Do not use anhydrous calcium chloride to make solutions; the reaction with water is highly exothermic and the water may boil |
| Eriochrome-T-black indicator solution in ethanol  Hazard will depend on whether ethanol or IDA is used as solvent  Flammable hazard warning symbol showing a red diamond containing a flame  DANGER  Highly flammable liquid and vapour  Or  Flammable hazard warning symbol showing a red diamond containing a flameIrritant hazard warning symbol showing a red diamond containing an exclamation mark Health hazard warning symbol showing a red diamond containing a person shaped shadow and a white star shape inside the shadow  DANGER  Highly flammable  Harmful if swallowed  May cause damage to organs | Eriochrome-T-black solid  C20H12N3O7SNa (s)  MW= 461.381 g mol–1  Currently not classified as hazardous  Ethanol  C3H6O (l)  Flammable hazard warning symbol showing a red diamond containing a flame  DANGER  Highly flammable  Or  Ethanol (IDA – contains 95% ethanol)  Flammable hazard warning symbol showing a red diamond containing a flameIrritant hazard warning symbol showing a red diamond containing an exclamation mark Health hazard warning symbol showing a red diamond containing a person shaped shadow and a white star shape inside the shadow  DANGER  Highly flammable  Harmful (ingestion)  May cause damage to organs |

Disposal

All solutions can be diluted further and poured down a foul-water drain.

Dispose of water filters and dipsticks in the general waste.

Activity 2: investigating ion-exchange filters

Equipment (per group)

* 1 × boiling tube per filter tested
* 1 × boiling tube rack
* 5 cm3 measuring cylinder or plastic syringe
* 1 × 250 cm3 beaker
* 1 × 600 cm3 beaker
* Clamp and stand
* 1 cm­­3 pipette
* Permanent marker pen
* A selection of commercial ion exchange water filters for testing. (Note: some filters can be used as purchased but others are easier to use with a filter funnel attached to them.)
* Safety equipment: safety glasses

Preparation

* Calcium chloride solution, CaCl2(aq) 500 ppm (one bottle per group)

Disposal

All solutions can be diluted further and poured down a foul-water drain.

Dispose of water filters and dipsticks in the general waste.

Activity 3: using dipsticks to measure the hardness   
of water

Equipment (per group)

* 6 × 50 cm3 beakers
* 6 commercial water hardness testing dipsticks and colour chart
* Dropping pipette
* Permanent marker pen
* Safety equipment: safety glasses

Preparation

* Calcium chloride solutions of five different concentrations of calcium: 100 ppm;   
  200 ppm; 300 ppm; 400 ppm; 500 ppm (25 cm3 of each concentration per group)
* Distilled water (25 cm3 per group)

Disposal

All solutions can be diluted further and poured down a foul-water drain.

Dispose of water filters and dipsticks in the general waste.