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, 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.

Note: all hazard symbol images are © Shutterstock.

Activity 1: measuring calcium concentrations

Equipment (per group)

- 6 × boiling tubes
- 1 × boiling tube rack
- 5 cm^3 measuring cylinder or plastic syringe
- 1 cm^3 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 cm^3 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 cm^3 of ammonium chloride solution (0.20 $mol\ dm^{-3}$) to 85.0 cm^3 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 cm^3 of ethanol)
- Calcium chloride solutions of five different concentrations of calcium: 100 ppm; 200 ppm; 300 ppm; 400 p ppm pm; 500 ppm (2 cm^3 of each concentration per group, per repeat) made by dissolving the following masses of solid $CaCl_2.6H_2O$ in 1000 ml of distilled water:

Concentration of calcium (ppm)	Mass of $CaCl_2..6H_2O$ (g)
100	0.55
200	1.09
300	1.64
400	2.19
500	2.73

- Distilled water for cleaning pipettes and testing (2 cm^3 per group, per repeat)

Chemical supplied for the practical	Preparation
EDTA – 0.01 $mol\ dm^{-3}$ LiCl (aq) Currently not classified as hazardous	EDTA, disodium salt, dihydrate solid $C_{10}H_{14}N_2Na_2O_8.2H_2O$ (s) MW= 372.24 $g\ mol^{-1}$  WARNING Harmful if swallowed Causes skin irritation Causes eye irritation Sodium hydroxide solid $NaOH$ (s) MW= 40.00 $g\ mol^{-1}$  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 $mol\ dm^{-3}$ NH_3 (aq) Currently not classified as hazardous but avoid breathing vapours Ammonium chloride solution, 0.20 $mol\ dm^{-3}$ NH_4Cl (aq) Currently not classified as hazardous

Chemical supplied for the practical	Preparation
Calcium chloride solutions – up to 500 ppm of calcium $CaCl_2$ (aq) Currently not classified as hazardous	Calcium chloride-6-water solid $CaCl_2.6H_2O$ (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  DANGER Highly flammable liquid and vapour Or  DANGER Highly flammable Harmful if swallowed May cause damage to organs	Eriochrome-T-black solid $C_{20}H_{12}N_3O_7SNa$ (s) MW= 461.381 g mol^{-1} Currently not classified as hazardous Ethanol C_3H_6O (l)  DANGER Highly flammable Or Ethanol (IDA – contains 95% ethanol)  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 cm^3 measuring cylinder or plastic syringe
- 1 × 250 cm^3 beaker
- 1 × 600 cm^3 beaker
- Clamp and stand
- 1 cm^3 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, $CaCl_2$(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 cm^3 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 cm^3 of each concentration per group)
- Distilled water (25 cm^3 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.