LESSON 2
GOOD ENOUGH TO DRINK – WHAT IS IN OUR WATER?

THE BIG IDEA

In this lesson students will answer questions about dissolved substances in water from London's water supply and other sources using a problem solving/ inquiry approach. In answering these questions students will be using ideas about pure and impure substances as described in the national curriculum chemistry as well as considering wider implications, including financial.

Whilst much of this lesson may contain ideas fully described at GCSE in terms of the chemistry, the treatment here is within the bounds of the key stage 3 curriculum. You may choose to go more deeply into the chemistry with more able students.

LEARNING OUTCOMES

Could compare the risks and benefits of hard water supplies and/or fluoridation of water.

Should devise a method to discover which water has dissolved solids in it.

Should be able to describe why water is described as hard or soft.

Must describe how to recover a dissolved solid or gas from a solution.

RESOURCES

Resource 2.1: Limescale pictures

Resource 2.2: Fake mineral water discovered on sale!

Resource 2.3: Analysis of powdered residue

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MATHEMATICAL SKILLS

Calculating percentage of dissolved solids in water.

KEYWORDS

- Dissolve
- Pure
- Solution
- Solubility
- Evaporation
- Lime scale
- Limestone
- Hard water
- Soft water
- Fluoride

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SETTING THE SCENE

TEA BREAK DURING VOCATIONAL TRAINING AT A CENTRE IN NEW CROSS, 1962

© Henry Grant Collection/Museum of London

Many people think London water makes the best cup of tea although others around the country may disagree. London water comes from an area of the country which has a lot of calcium carbonate rocks e.g. chalk and limestone. When rain collects in underground aquifers much of our water passes through the rock and collects underground and in our rivers. As the rain water is slightly acidic it slowly dissolves the rocks adding dissolved minerals to our water supply making the water what we call hard. Hard water makes great tea and supplies our bodies with calcium. Some people believe that water rich in calcium may supplement dietary calcium and protect against heart disease. However, it also leaves deposits in our kettles, washing machines and other water heaters when we use them.

Students will be encouraged to consider the following questions:

- What is dissolved in our drinking water?
- What does this mean for us in terms of health?
- Should we have fluoride added to our drinking water?
- Why is London water so hard?
- What is lime-scale?
- What effects does lime-scale have on us economically?

Fluoride is also added naturally to rain water from the rocks and is believed to protect children's teeth from decay. However adding fluoride to drinking water is controversial and is not actually done in London. Some believe fluoride can cause other health issues if the level is too high. Does this mean young people in London are at greater risk of decaying teeth or can the positive effects of fluoride be gained from toothpaste and mouth washes?

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ACTIVITIES

STARTER

Show students Resource 2.1: Limescale pictures (page 27) – images of kettles and heating elements that have been coated with lime-scale and also pipes that have been blocked. Ask students: What do you think happened to these?

MAIN 1: WHAT IS DISSOLVED IN MY DRINKING WATER? IS IT PURE?

Ask students to brainstorm a method to investigate the differences between tap water, distilled water and sea water; they could also include bottled water. Students should be able to recall from primary school how to recover dissolved solids from solutions; they could then be shown the method.

Using Resource 2.2 Fake mineral water on sale! (page 28) – What is dissolved in the water samples? Students devise a test to identify different water samples. Show them how to heat the watch glasses safely over a beaker of boiling water once they have decided on a plan to identify the different water samples.

Differentiation

More able students could devise a way to calculate the percentage of dissolved solids in a given volume of water.

Equipment needed:

- Water samples labelled A B C D containing tap water, distilled water, sodium chloride solution and mineral water (commercial or made from a weak solution of suitable minerals)
- Bunsen burner, Tripod, gauze and bench mat
- 250cm^3 beaker
- Watch glass
- Safety goggles

For further support see:
www.rsc.org/learn-chemistry/resource/res00001783/to-find-out-if-tap-water-and-sea-water-contain-dissolved-solids

(Alternatively you could set up watch glasses at the end of last lesson and allow the water to evaporate slowly, though this would miss the chance for students to devise their own method.)

The teacher demonstration in the above reference shows that there are also gases dissolved in the water and makes a good link to biology, and the reliance of fish and other life forms on dissolved oxygen. (Students may be interested to know that there is more oxygen in the dissolved gases in water then normal air due to differences in solubility of gases.)

MAIN 2

(Optional if there is time available – it could be a short teacher demonstration)

Once the samples are collected ask students to try to analyse the solids using the instructions in Resource 2.3: Analysis of powdered residue (page 29).

Students can do further tests to help prove the existence of calcium carbonate using hydrochloric acid on the residue of sample they believe to be tap water.

As a teacher demonstration, dissolve some residue from the tests in methanol and set fire to it to see the colour of the flame. You may need to have a sample ready for the demonstration if students have tested all of theirs with acid.

Differentiation

Students can be given a table to record results from given tests, see Resource 2.3: Analysis of powdered residue (page 29).

MAIN 3

Discuss with students: How is London tap water different to rain water? What do we mean by hard water?

Ask students to measure out 10cm^3 tap water in a stoppered boiling tube and add soap solution 1cm^3 at a time with shaking until they get a lasting lather. If time permits they can compare this to distilled water which has the hardness removed i.e. is soft water. Discussion can include why we might prefer not to have hard water.

For reference see:
www.rsc.org/learn-chemistry/resource/res00000426/testing-the-hardness-of-water

This is a long practical more aimed at key stage 4 but may suitable for some key stage 3 groups.

Plenary : Is it better to have hard water or soft water?

How hard is the water in your area?

Visit this website to put in postcode and get a measure for water hardness in your area:

my.thameswater.co.uk/dynamic/cps/rde/xchg/corp/hs.xsl/899.htm

Look back to the starter pictures in Resource 2.1: Limescale pictures (page 27).

Why do humans need calcium in their diet?

Ask students to write a couple of sentences to describe the pros and cons of hard water like we have in London.

Is London tap water pure?

Differentiation

Provide sentence starters for students that require some support.

Homework ideas

- Collect and test lime-scale from the kettle at home with vinegar. Record where lime-scale can be found in the home and investigate cleaning products which suggest they remove lime-scale by looking at the labels to see what chemicals they have in common.
- Undertake a project to consider whether London should add fluoride to drinking water. They would need to conduct an internet search and be encouraged to consider the evidence for and against and to write a short piece to reflect their own point of view.
- Use a table of data on dental decay as a starting point to explore the state of children's teeth in different London boroughs.

Further reading

What's in your water? How is hard water created?
www.thameswater.co.uk/help-and-advice/18136.htm

Sources of hardness – minerals in drinking water US water research:
www.water-research.net/index.php/water-treatment/tools/hard-water-hardness

Hard water stops heart attacks:
news.bbc.co.uk/1/hi/health/3396141.stm

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RESOURCE 2.1: LIMESCALE PICTURES

INSIDE A LONDON KETTLE
Image by Henna

AN INDUSTRIAL PIPE THAT CARRIES WATER
Image by Aleksandr Lebedev

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RESOURCE 2.2: FAKE MINERAL WATER DISCOVERED ON SALE!

Your group has been employed as local environmental health officers working for Trading Standards. You have been asked to identify some samples of water being sold as mineral water. They are thought to be:

- Tap water
- Rainwater
- Bottled mineral water
- Sea water

You have only the following apparatus to hand:

- Bunsen burner, tripod, gauze and bench mat
- 250cm^3 beaker
- Watch glass
- Safety goggles

You have limited time so you need to collaborate with other officers to get the answer as quickly as possible.

Devise a test that could be used to decide which water is which. Your teacher will need to conduct a safety check before you start.

Caution.

Trading Standards needs you to work accurately and efficiently. Tests must be reliable and repeatable otherwise the wrong people may be prosecuted.

Please write a brief summary of your findings including a table of results.

You should include in your report the following keywords:

- Evaporate
- Dissolve
- Solution
- Soluble
- Pure water

Extra challenge

To determine the concentration – calculate what percentage of the sample is dissolved solids.

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RESOURCE 2.3: ANALYSIS OF POWDERED RESIDUE

To be absolutely sure your answer in the last test is correct, you can conduct further tests on the powders left at the end.

1. **Test for calcium carbonate**
   Add one or two drops of dilute hydrochloric acid and look for fizzing. This will prove you have a carbonate like calcium carbonate. Calcium carbonate is left when tap water from London is evaporated.

2. **Test for sodium chloride or calcium carbonate using a flame test**
   Your teacher will demonstrate this with a sample to show that sodium is present. Sodium makes a flame turn bright yellow. Calcium makes a flame turn orangey red. Sodium chloride is ordinary salt left when sea water is evaporated. Calcium carbonate is left when tap water from London is evaporated.

SAMPLE	OBSERVATIONS WHEN DILUTED WITH HYDROCHLORIC ACID	OBSERVATIONS WHEN A FLAME TEST IS CARRIED OUT
A		
B		
C		
D		

LESSON 3
WHAT SHALL DO WITH ALL THE WASTE?

THE BIG IDEA

London sewage treatment was developed to protect Londoners from water borne disease. Now the Thames Tideway tunnel is being built to help the sewage system cope with the rising London population. This lesson will allow students to conduct experimental work to model water treatment and have a chance to consider the importance of water analysis. An understanding of separation techniques in a real context will be developed.

The role of environmental health and water borne disease will also be considered.

LEARNING OUTCOMES

Could describe the use of separating techniques, filtration and distillation in the context of water purification.

Should devise a simple method to filter dirty water and evaluate the result in terms of how good a model they have produced to producing drinking water.

Must describe how filtration works to remove solid waste and why this cannot work for dissolved particles.

Must describe the role scientists can take in maintaining water quality.

RESOURCES

Resource 3.1: Investigating how we can clean up water

Resource 3.2: Watching a video LSS activity

Resource 3.3: Sentence starters

Resource 3.4: A day in the life