Water – a matter of taste or a taste of matter?
Is all water the same?

Ask pupils if they think that all water tastes the same. Then pour out a sample of tap water from a large jug into a cup for each pupil and ask them to taste it and say if it tastes of anything.
Now put a little salt into a sieve over a clean jug and ask what will happen if water is poured over the salt. Pour the water over the salt and ask them to taste the result.

Repeat the activity, using sugar in place of the salt. Now put a clean stone into the sieve, ask what will happen when water is poured over it and then do so.

Ask the pupils if they expect the water to have a taste and then let them taste it. Explain that virtually nothing has dissolved from the stone in the few seconds during which the water was poured over it, but that water flowing through rocks for thousands of years can indeed dissolve measurable quantities of 'chemicals'.

Ask pupils to look at the table showing an average analysis of rain water, compared to that of natural mineral water, flowing out of St Ann's Spring at Buxton, in the Peak District in England.

Salt Brown sugar A clean stone

Name of water	Chemical analysis in milligrams per litre (mg/l)							
	Calcium (Ca^{2+})	Magnesium (Mg^{2+})	Potassium (K^{+})	Sodium (Na^{+})	Bicarbonate (HCO_3^{-})	Chloride (Cl^{-})	Sulfate (SO_4^{2-})	Nitrate (NO_3^{-})
Rain water	0.1	0.2	0.2	2.1	0.1	0.4	0.6	Not stated
Buxton mineral water	55	19	1	24	248	37	13	<0.1

Sources of data: Rain water – Open University website (see 'Useful Links'); Buxton water – label on bottle, 2012

All the water which flows from springs was once rain water, which has soaked through the ground before it comes to the surface again. Nothing was added to the mineral water by the firm which bottled it, so can pupils explain why the composition is so different from the rain water? Ask pupils to read the text opposite, taken from the label of a bottle of Buxton mineral water.

Tell pupils that the Buxton water label also includes a rather imaginative 'geological cross section' passing through "limestone", "grits and shales" and an "ancient lava flow". Does this help pupils to expand on their answers to the question above?

"**A little bit of Britain in every bottle**
Our water fell as rain 5,000 years ago on the rolling hills of the unspoilt Peak District. During its deep underground journey, it slowly filters, collecting lovely minerals which give Buxton water its unique balanced and refreshing taste. Day after day it rises naturally at St Ann's Spring, in the heart of Buxton town. We bottle it directly at source, for you to enjoy wherever you are.
Buxton. A drop of pure Britain".

A label from a bottle of mineral water, showing its chemical composition and its supposed route from rainfall to spring

The back up

Title: Water – a matter of taste or a taste of matter?

Subtitle: Is all water the same?

Topic: Pupils are asked to investigate how water can dissolve solids and to taste the result. They compare the chemical composition of rain water with bottled mineral water and discuss the differences.

Age range of pupils: 8 – 16 years

Time needed to complete activity: about 30 minutes

Pupil learning outcomes: Pupils can:
- dissolve common soluble compounds in water and taste the result;
- understand that water may acquire dissolved compounds in its passage through the ground and that this may take a considerable time;
- compare real data of water chemistry presented in a table;
- discuss the reasons for the differences in water quality from a range of samples

Context: The origins and purity of potable water are clearly vital to human existence. This topic may be covered at all levels, with a simple explanation of the 'chemicals' in water for primary age pupils compared with older students who will be familiar with chemical symbols expressed in ionic form.
Can pupils explain why the composition of this example of Buxton spring water is so different from rain water? *The water has dissolved 'chemicals' from the rocks through which it has passed on its way from the catchment area to the place where it emerges in springs. The nature of the chemicals depends on the composition of the rocks themselves.*
Can pupils expand on their answers to the question above? *The high levels of calcium and bicarbonate ions result from the solution of limestone (calcium carbonate). The magnesium probably also comes from the limestone, which contains the mineral dolomite (calcium magnesium carbonate) as well as calcite (calcium carbonate). The sodium and the chloride ions come from sodium chloride, trapped within several different types of rock underground. Nitrate levels are low because the surrounding countryside is mainly grazing land which does not receive heavy doses of fertilisers, and the water has travelled deep below ground. Sulfate ions may originate from weathered pyrite occurring in the shales through which the water has passed, or possibly from sulphide ore minerals in the limestone.*

Following up the activity:
- Collect bottled water labels which give the chemical composition of the dissolved salts. Enter the data onto the table and compare them.
- Collect any labels which claim to tell the history of the water, e.g. "flowed through volcanic rocks for thousands of years, giving the water its unique flavour".
- Discuss how accurate these statements might be.
- Explain the difference in pH values of rainwater (average pH = 5.7) and Buxton water (pH = 7.4). (*The rain water contains naturally dissolved carbon dioxide from the atmosphere, making it slightly acid; it may also contain dissolved nitrogen and sulphur oxides from pollution).*
- Measure the pH of tap water in the school laboratory, and discuss why it is usually greater than pH =7 *(Alkalis are added at the treatment plant in order to reduce dissolution of lead or copper from water pipes).*
- Find a mineral water bottle where the levels of nitrate ions (NO_3^-) are high (*The water has travelled along a relatively shallow path through the ground and has picked up nitrate ions from fertilisers added to the soil above.)*
- Look at the Buxton water website (http://www.buxtonwater.co.uk/ourwater/purified-naturally.aspx), to see a cartoon animation of the origins of the water.
- Look at ELI 'Watery world of underground chemistry'

Underlying principles:
- Natural rain water has a relatively low content of dissolved material.
- Mineral or spring water has a very variable content of dissolved material, depending on the route which the groundwater has taken, and the length of time since it fell as rain on the catchment area.
- The European Commission defines 'Natural mineral water' as "microbiologically wholesome water originating in an underground water table or deposit emerging from a spring tapped at one or more natural or borehole exits". It is bottled in an untreated state.
- The term 'spring water' is used for underground water which may not meet the strict conditions laid down for 'mineral water', but which is nevertheless safe to drink. Some spring water has been treated before bottling.
- The 'age' of the water can be obtained by radiocarbon and other radiometric methods of dating.

St Ann's Well at Buxton (Photo: *Peter Kennett*)

Thinking skill development:
The practical work involves the process of construction. Relating this to the real world is a bridging process.

Resource list:

- a clean kitchen sieve or tea strainer. A piece of muslin may be needed to stop small grains of salt or sand slipping through.
- a large jug
- a cup per pupil
- salt
- sugar
- a clean stone
- tap water in a jug
- one or more samples (or labels) of different bottled mineral or spring water
- a copy of the table per pupil

Useful links: Try Earthlearningidea activities: 'From rain to spring: water from the ground', and 'The watery world of underground chemistry'.
The Buxton water website (Note that this is one of many commercial websites and no endorsement of any particular product is intended. This just happens to be the nearest source to the author's home!).
http://openlearn.open.ac.uk/mod/oucontent/view.php?id=399809&section=1.1

Source: Written by Peter Kennett of the Earthlearningidea team, based on "A few thoughts on water labels, strontium isotopes and cross curriculum activities for primary KS2", by Hazel Mather in *Teaching Earth Sciences* 36.1, 2011 and on "Bottled water – a teaching resource" by Hazel Clark in *Teaching Earth Sciences* 35.2, 2011.