Why is the Dead Sea dead?
Measuring salinity

Lakes and seas in inland desert areas like the Dead Sea and the Great Salt Lake are famous for being so salty that hardly anything can live in the water.

You can tell they are salty because it is very easy to float in them – and very difficult to swim. But just how salty are they?

Floating in the Dead Sea.

Common salt (sodium chloride, NaCl) and other chemicals are extracted from salt lakes when the water is evaporated and the salt is left behind. Scientists measure how this process is progressing by measuring the density of the solution, because as the water evaporates, the solution becomes more and more dense.

A scientist measuring the density of the salty water of the Dead Sea to find out how much more evaporation is needed before salt will crystallise from the solution. *(Photo: Chris King)*

Salt crystallising from Dead Sea water. This boulder is made of salt. *(Photo: Chris King)*

Try this in the classroom by making your own 'salinity tester' from a plastic drinking straw with some clay or Blu tac™ attached to one end, as shown in the photo. Add tap water to a measuring cylinder to the highest mark, put in your 'salinity tester', tap the straw gently to make sure it is floating freely, and then record how high it floats. Repeat this with salty water and then brine. You will find that the more salty the water, the higher your tester will float.

A 'salinity tester' floating in water of different salinities. *(Photo: S Allen and G Jones).*

You can roughly calibrate your tester by measuring how high it floats in fresh water and then how high it floats in brine. Plot a graph from 'Water containing no salt' on the left to 'Water saturated in salt' (containing as much salt as possible) on the right. Then use your graph to find out how much salt an unknown solution of salt contains.

The back up

Title: Why is the Dead Sea dead?

Subtitle: Measuring salinity

Topic: A classroom activity to measure the density of water of different salinities.

Age range of pupils: 10-20 years

Time needed to complete activity: 20 minutes

Pupil learning outcomes: Pupils can:
- describe how dissolving salt in water increases the density of the water;
- describe how a 'floater' can be used to measure the density of solutions.

Context:
The Dead Sea in the rift valley between Jordan and Israel is the lowest point on land on the Earth's surface. Most of the water that flows into the Dead Sea does not flow out again but is evaporated in the highly arid conditions. The situation is similar in the Great Salt Lake of Utah, USA, and in other inland basins worldwide. It is economically viable to increase the evaporation of this salt solution commercially, by forming a series of evaporating ponds. The progress of the increasing salinity in these ponds as the water evaporates, can be measured by the use of salinity testers in measuring cylinders, as shown in the photo above. Eventually the highly concentrated salt solution, or brine, is pumped into an industrial plant like the one shown in the photo below, for the different salts to be extracted.

The composition of Dead Sea salt is very different from that of sea water, comprising the cations of Magnesium (Mg – 45,900 mgl^{-1}), Sodium (Na - 36,600 mgl^{-1}), Calcium (Ca - 17,600 mgl^{-1}) and Potassium (K – 7,800 mgl^{-1}) and the anions chloride and bromide (Cl and Br – 230,400 mgl^{-1}). Dead Sea salt is extracted by both Israel and Jordan and is sold for industrial and therapeutic purposes. It is one of Israel's major exports.

Industrial plant on the shores of the Dead Sea, recovering different salts from Dead Sea water. *(Photo: Chris King)*

The main water source for the Dead Sea is the River Jordan, but since much of this is now used for irrigation, whilst brine extraction continues, the surface of the Dead Sea has sunk well below its former levels in recent years – so that Dead Sea water now has to be pumped up from the Dead Sea into the brine ponds.

Salt lakes in inland basins are common in many arid areas of the world, such as in parts of North and South America, Spain, Northern, Eastern and Southern Africa, Australia and large parts of central Asia.

Following up the activity:
Ask the pupils to type 'Dead Sea salt' into a search engine like Google™ to discover for themselves the therapeutic claims made for 'Dead Sea salt' and 'Dead Sea mud'.

Underlying principles:
- The more salt is dissolved in water, the denser the water becomes.
- The density of different solutions can be measured by how high a hydrometer (or 'salinity tester') floats in the fluid.

Thinking skill development:
Visualising how the measurement of the density of a liquid in the lab equates to the commercial measurement of density in situations like that of the Dead Sea and the Great Salt Lake is a bridging exercise.

Resource list:
- 50 ml measuring cylinder
- plastic drinking straws
- Blu tac™ or clay
- salt (sodium chloride - NaCl)
- water

Useful links:
You can find many photographs of salt lakes across the world by typing 'salt lake' into a search engine like Google™ and clicking 'images'.

Source: The 'salinity testers' were devised by Suzy Allen and Gwyn Jones, of the Education Department at Keele University, after testing a variety of alternatives. The activity was written by Chris King of the Earthlearningidea Team.