PUPIL
RESEARCHER
INITIATIVE

Sea Chemistry

Setting the Scene

You will carry out one or more investigations on the chemicals dissolved in sea water. Your investigation will be based on a question, an hypothesis or a prediction, relating to the chemical composition of sea water.

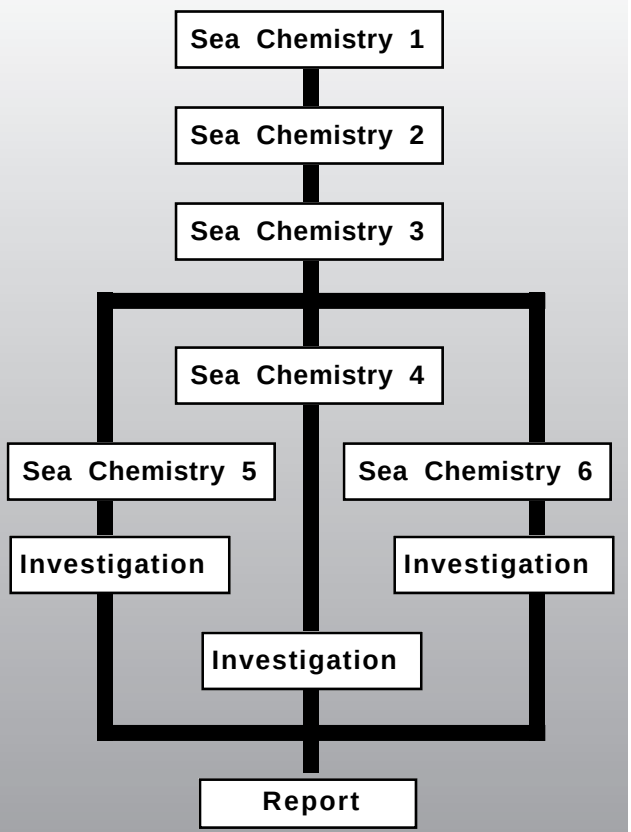
Pupil Research Brief

Study Guide

Syllabus Targets *Science you will learn about in this Brief*

- ❑ mixtures contain constituents that are not combined
- ❑ mixtures can be separated by evaporation and distillation
- ❑ solutes, such as salts, have different solubilities in water
- ❑ the solubility of most solutes increases as the temperature increases
- ❑ the boiling point of water is used to test for the purity of water
- ❑ distillation of sea water leaves all dssolved compounds behind and produces pure water
- ❑ when an ionic substance, such as salt is dissolved in water the ions are free to move about allowing the solution to conduct electricty

Route through the Brief



Outcome Checklist

You will carry out one or more investigations based on a question, an hypothesis or a prediction. You will write a report of your findings and plan a short presentation to the class. You can use the *Investigation Flowchart* to help you plan your investigation. You should make sure you produce the following items as you work through the Brief.

Sea Chemistry 1 and 2

- ❑ brief notes summarising the information

Sea Chemistry 4, 5 and 6

- ❑ report on investigation(s)
- ❑ presentation

Sea Chemistry 1

What chemicals are in the sea?

The sea is mainly water - but there are lots of other things in it. The most common substance in sea water is sodium chloride, or salt. Other substances in sea water include calcium sulphate and magnesium sulphate. There are also a lot of other substances in the sea, such as tiny amounts of metals like copper and iron.

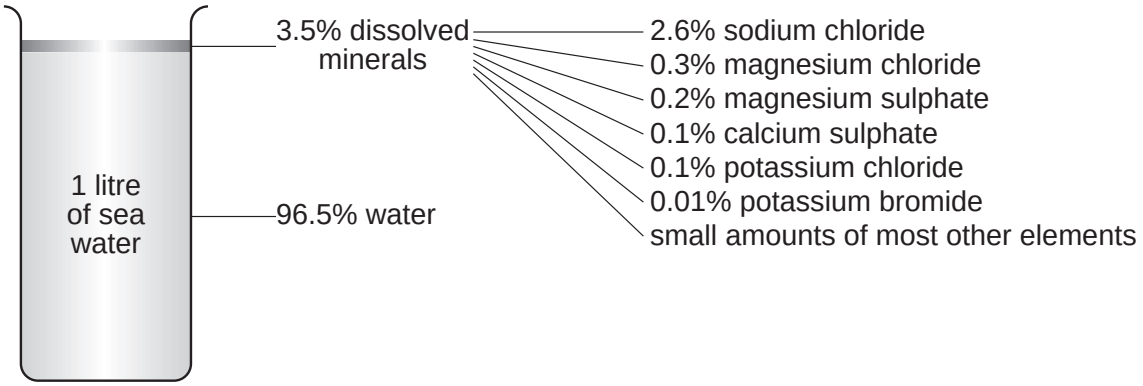


Figure 1. Composition of sea water

There are many chemical reactions continually taking place in the sea. Numerous microscopic plants and animals living in the sea use the chemicals dissolved in sea water. For example, calcium and hydrogen carbonate ions are used to make their shells. Research scientists in this country are studying sea slugs and their eggs to find out how they use substances dissolved in water to make complex chemicals to do important jobs in their bodies. Some of these chemicals are also being studied for their possible use as new drugs.

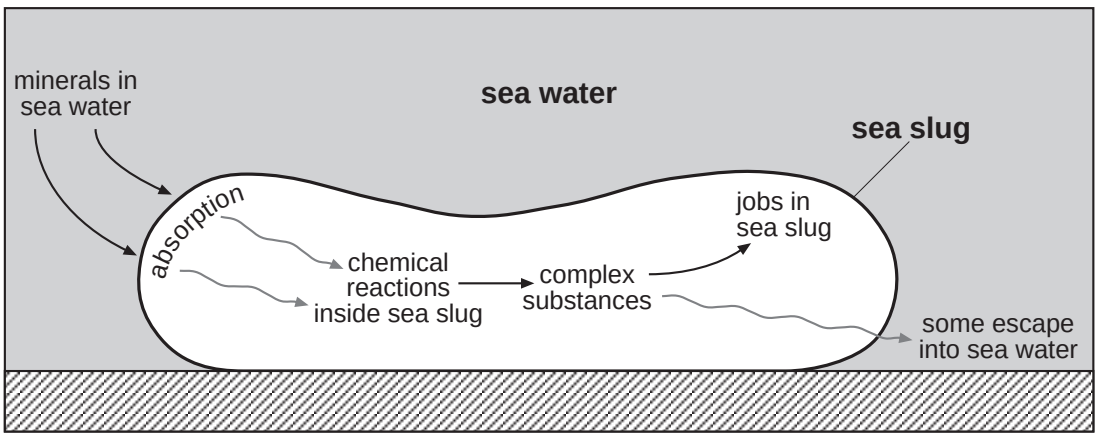


Figure 2. How sea slugs use chemicals from sea water

Sea chemistry 2

Other researchers have found that even dead plants and animals take up dissolved metals in sea water onto the surfaces of their bodies. Other UK scientists have discovered a second source of water flowing into the oceans, other than from streams and rivers, adding to the chemistry of the sea. This source is due to the movement of hot water within the rocks of the sea bed which then flows up as hot springs from cracks and openings on the sea floor.

Within these hot springs, which occur all over the ocean floors, there are dense, black, billowing plumes of smokey particles. Many chemical reactions are taking place between these particles and the substances dissolves in sea water. It is as a result of these chemical reactions that scientists think elements are removed from solution. They think that these hot water springs and sea bed chimneys could be important in maintaining the balance of the sea water chemical cocktail. They could also help us understand how sea chemistry copes with pollutants such as cadmium and lead.

Chemicals from the sea

One cubic metre of sea water contains about 26kg of sodium chloride, 5kg of magnesium salts, 1 kg of calcium sulphate and 1 kg of potassium salts. Since over two-thirds of the Earth's surface is covered by sea water, this adds up to a huge amount of chemicals in the sea.

In many hot countries, salt is obtained by evaporating sea water in large shallow pools. By carefully controlling the evaporation process sodium chloride can be obtained in a fairly pure state.

Sea water is also a major source of the elements magnesium, bromine and iodine.

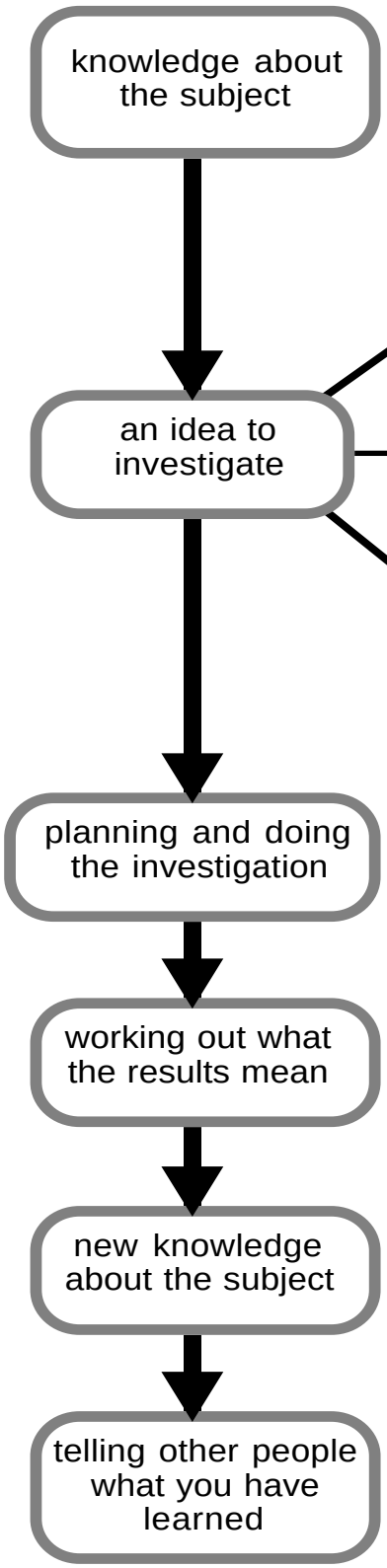
Fresh water from the sea

Today there are around 8000 desalination (salt removing) plants worldwide producing vast amounts of fresh water from sea water each day. Although the majority of these are in the Middle East there are rapidly growing numbers in North America, Europe and Africa. Most desalintation plants use distillation techniques which require a lot of energy. Water obtained by this process is about five times more expensive than normal. However, researchers are trying to harness renewable energy from the Sun and the sea to power desalination units. The 'solar distiller' can produce 20 litres of distilled water per square meter of solar collector. The 'nodding duck' or 'desalinating' duck being trialled in Scotland uses energy to produce around 1000 cubic meters of fresh water daily.

Sea Chemistry 3

Scientists do experiments and investigations. They use their knowledge to think of new ideas that they can test. The ideas could lead to new knowledge about the subject they are investigating.

Steps in an investigation



Take one starting point for your investigation

this could be a question - the investigation might lead to an answer to the question - try answering the question on sheet Sea Chemistry 4

this could be an explanation for something which has been observed - the investigation might show whether the explanation is correct or not. An explanation is sometimes called an hypothesis. Try testing the hypothesis on sheet Sea Chemistry 5

this could be a prediction about what might happen if... the investigation might show whether the prediction was correct or not. Try testing the prediction on sheet Sea Chemistry 6

this could be the starting point for another investigation, to find out even more new knowledge

a written report, a talk, a poster or a script for a programme

ASKING QUESTIONS

You are going to carry out an investigation to find out the answer to a scientific question.

A cubic metre of sea water contains about 26 kg of sodium chloride, about 5 kg of magnesium salts and about 1 kg of calcium sulphate. When you think that over two-thirds of the Earth's surface is covered by seas, this adds up to a massive amount of chemicals!

In many tropical countries salt for cooking and for food is obtained by evaporating sea water in the hot Sun from large shallow pools. It is very useful to know the solubility of the salts present in sea water when carrying out this method.

(The solubility of a solid in water at a particular temperature is the maximum mass of the solid which will dissolve in 100 g of water at that temperature).

The question is:

What are the solubilities of three of the most common salts in sea water - sodium chloride, magnesium chloride and calcium sulphate?

Your group should try to answer this question. Plan and carry out an investigation to determine for yourselves the solubilities of the three salts. You could share the task within your group and pool results. Make sure the investigation is a fair test.

Use the **Investigation Flowchart** to help you set out your plans.

When you have finished the investigation use your results to help you answer the question. The answer is **not just the results** - you have to **think** about what the results mean. This will give you your answer. The answer may now mean you know something new about sea chemistry. Write a report and plan a short presentation to the class to tell them what you have learned.

Hypothesising

Over two thirds of the Earth's surface is covered by seas - this adds up to a huge amount of salt water! In many hot countries, particularly those in the Middle East, fresh water is in short supply. They have to obtain fresh water from sea water in large desalination plants.

You are going to plan and carry out an investigation to test the hypothesis on which the process of getting fresh water from sea water depends:

a pure solvent can be obtained from a solution by the process of distillation.

The science this hypothesis is based on is:

in a solution of sodium chloride sodium ions and chloride ions are surrounded by water molecules.

As the solution is heated, more and more of the water molecules are able to escape as a vapour. The sodium and chloride ions that are left behind are able to meet and start to form solid sodium chloride crystals. Eventually, when all the water is gone there is only solid sodium chloride left behind. The water vapour can then be condensed back to a liquid in a separate container.

You now have to think about how you can get evidence to show that the hypothesis is correct or not.

Use the **Investigation Flowchart** to set out your ideas.

When you have finished the investigation use your results to think about whether the hypothesis is correct or not. The answer is **not just the results -** you have to **think** about what the results mean. This will give you your answer. The answer may mean you now know something new about sea chemistry. Write a report and plan a short presentation to the class to tell them what you have learned.

You may also like to hypothesise about whether water containing dissolved substances, (like sea water for example), needs more or less heat energy to boil it than distilled water. It may be possible to test out your hypothesis - check with your teacher.

Sea Chemistry 6

MAKING PREDICTIONS

You are going to plan and carry out an investigation to test this prediction:

sea water will conduct an electrical current but distilled water will not.

The science this prediction is based on is:

sea water is an electrolyte. An electrolyte contains charged particles (ions) which can move through it carrying current. In sea water the ions are from the dissolved salts which it contains. Distilled water does not conduct electricity because it contains hardly any ions at all.

When an ionic solid, such as a salt, is dissolved in water, its ions are free to move and carry the current. So if a battery is connected to an electrolytic cell, one electrode becomes positively charged and the other negatively charged. The ions are attracted to the electrode with the opposite charge and move through the solution towards it.

Negative ions lose electrons to the positive electrode.
Positive ions gain electrons from the negative electrode.
This is how the electrical current is carried through the solution.

You now have to think about how your group can get evidence to test the prediction. You should use the **Investigation Flowchart** to set out your ideas and to plan and carry out your investigation.

You may also like to predict how the electrical conductivity (ability to conduct electricity) of your sea water sample might be affected by temperature or the amount of dissolved salts it contains. Also, try to come up with a scientific explanation for your prediction.

When you have finished your investigation, use your results to think about whether the prediction was correct or not. The answer is **not just the results** - you have to **think** about what the results mean. This will give you your answer. The answer may mean you now know something new about sea chemistry. Write a report and plan a short presentation to the class to tell them what you have learned.

INVESTIGATION FLOW CHART A

PLANNING AHEAD