

A Pinch of Salt – Key Stage 2

Introduction

These resources are aimed at children aged 9 - 11 years old and provide a focus for planning and carrying out science based activities. They can be used in their entirety or activities can be selected to support another teaching programme. The activities are consistent with the following statutory requirements of the 2014 English curriculum:

- know that some materials will dissolve in liquid to form a solution, and describe how to recover a substance from a solution
- use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating
- demonstrate that dissolving, mixing and changes of state are reversible changes

These activities also provide opportunities for 'Working Scientifically' and teachers will find the ideas adaptable for other age-groups.

The main focus of the activities is the science related to salt's use as a de-icer on roads during cold weather. The activities are linked using a cartoon character 'Chris' who discovers a salt bin at the end of the street and learns that using salt on roads has advantages and disadvantages.

During the series of science investigations, children learn about:

- The effect of salt on melting ice.
- The difference between melting and dissolving.
- Evaporation of water from a salt solution, leaving salt crystals.
- The effect of surface area on the rate of evaporation of water from salt solution.
- Obtaining table salt from rock salt, by dissolving, filtering and evaporating.

These activities are based on the Centre for Industry Education Collaboration's Pinch of Salt cross-curricular pack. For additional activities see www.ciec.org.uk.

Curriculum areas

Working scientifically

- Planning and performing investigations.
- Measuring, recording, presenting data and reporting findings.
- Predicting, analysing and explaining results.

Properties and changes of materials

- Dissolving and recovery of materials from a solution.
- Melting and reversible changes.
- Separating mixtures by evaporation.

Safety notes

A full risk assessment, incorporating any school or local policies, should be performed before carrying out practical activities. Some safety notes are included for consideration when risk assessments are being produced. These should not be seen as taking the place of a risk assessment.

Salt and science in a context

The activities focus on the use of salt as a de-icer for roads. They are linked using a cartoon character, Chris, who discovers a salt bin at the end of the street and learns that using salt on roads has advantages and disadvantages.

Table salt is used for Activities 1-5 and rock salt is used for Activity 6. The chemical name for table salt is sodium chloride and, when not mixed with anything else, is 'pure'. Rock salt is used on icy roads and is a mixture of salt, grit and marl.

Many of the activities involve the children in planning their own investigations. The teacher must decide how much additional support is given to the children, depending on their understanding and confidence with investigative work. If required, support materials have been produced for all the activities.

A 750 g container of table salt and 1 kg of rock salt will be sufficient for a class to complete all activities. Rock salt is inexpensive and can be bought from building suppliers. If stored, keep in a sealed bag as the salt will absorb moisture from the air.

In the primary school the terms weight and mass are often used synonymously. Scientifically speaking this is incorrect. The weight of an object is its mass multiplied by the gravitational force acting on it. Weight is measured in newtons and mass in kilograms. In these notes the term 'weight' has been used, as it is not an aim of the activities to teach this concept. The teacher may choose to use the term 'mass' if children have some prior knowledge of the difference.

What is Salt?

Salt contains two elements, sodium and chlorine; hence its chemical name is sodium chloride. The chemical symbol for sodium is Na (an abbreviation of the Latin name for sodium which is natrium) and the symbol for chlorine is Cl. So scientists sometimes abbreviate salt to NaCl.

Salt has been used to improve flavour or preserve food for thousands of years. More recently it has been used to de-ice roads in countries where winter temperatures fall below zero degrees Celsius (the freezing point of water). Most people are familiar with these applications, which together account for approximately 30% of the total world salt production.

A small quantity of the salt used in Britain is mined underground by cutting, drilling and blasting, but most salt is extracted by pumping water down into the rock. The salt dissolves and is brought to the surface as a solution called brine. This process is called solution mining. Salt is also obtained by evaporating sea water. Sea salt is used for culinary purposes.

Salt is used in many processes and products. Just a few are listed below:

- Caustic soda, used to make soap.
- Washing soda, used to soften water.
- Baking soda, used to raise bread.
- Bicarbonate of soda, used as medicine and in baking.
- Sodium silicate, used to make glass.
- Chlorine is a powerful bleaching agent which kills bacteria. It is used as a sterilising agent to purify drinking water, sterilise swimming pools, sterilise baby feeding bottles and as domestic disinfectants.

- Chlorine is used in the manufacture of plastic (such as PVC) used to make plastic bottles, water pipes, window frames, fabrics and car components.
- Adhesives
- Fire extinguishers
- Floor tiles
- Pesticides
- Pharmaceuticals (medicine)
- Skin creams

Activity 1 Salt as a de-icer

Children investigate the effect of adding salt to ice at room temperature.

Aim

To understand that adding salt to ice causes the ice to melt faster.

Resources

A selection from:

- Copies of Activity sheets 1a- 1b
- Salt
- Ice cubes
- Tidy trays
- Stop clocks or stopwatches or egg-timers
- Funnels
- Plastic jugs
- Yogurt pots
- 20 ml plastic measuring cylinders (or teaspoons, as non-standard or 5 ml measures)

Other resources, depending on the children's planned investigations.

Context

Sheet 1a provides the stimulus for this activity and is intended to promote class discussion once children have completed the final box. The cartoon introduces the character Chris, who is featured throughout the activities. Chris moves to a new house at the top of a steep road and discovers a container of salt nearby. Chris does not know what the salt is for.

Children fill in the final box of the cartoon with their suggestion for the salt's use. Most children are aware that such containers of salt are used to de-ice roads in winter and will have drawn this option in the final box. The teacher can also complete a cartoon strip, which can be used if children have not thought of the possibility of de-icing.

Activity sheet 1b prompts an investigation into the use of salt on roads. On this sheet Mum tells Chris that salt is put on icy roads in winter. Children plan a test to find the answer to Chris's question, "What good will that do?" They are guided through the planning stages, by considering resources, 'fair' test conditions, and what and how they will measure and record.

Note that the focus of this activity is the speeding up of the melting process (at room temperature). The concept of the salt solution being a liquid at temperatures below zero degrees centigrade is very difficult for children to understand, and should not be tackled. An explanation of the change in temperature is provided in Appendix 1 for teachers.

Investigation

The following ideas for investigations may be used with children who have difficulties with open-ended tasks of this nature. They are not intended to be given to children before they have tried to devise their own investigation.

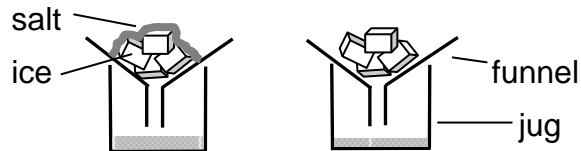
Option 1

Start with two yogurt pots, each containing equal numbers of ice-cubes. Cover the ice cubes with salt in one of the yogurt pots. The time taken for both tubs of ice to melt can be measured.



Option 2

Place two funnels, each containing equal numbers of ice cubes, resting above two jugs. Cover one set of ice cubes with salt. Collect the water that drains from the melting ice cubes and measure the volume at regular time intervals.



During planning the children must decide on quantities of salt and ice, whether to stir the mixtures, drain water away, add more salt at regular intervals, etc. If children want to change their investigation once they have started, they should give the teacher a valid reason before doing so.

Recording the activity

Results are best initially jotted down in a table during the test. During quieter moments of the investigation, the results can be transferred to a bar chart or a line graph. The choice of graph will depend on the ability of the children. Different coloured bars or lines can represent the ice with and without added salt.

Note that it is advisable for children to prepare their table layout before beginning their investigation. Some children will require support to achieve this, or the teacher may prepare blank tables for those with learning difficulties.

Extension activity

The children find out if other substances (for example, sugar, flour or sand) speed up the melting of ice in a similar way to salt. They can research the advantages and disadvantages (e.g. costs) of using these substances on the road.

Discuss the fact that rock salt can also provide friction for car tyres on icy roads

Handy hints

To prevent the ice melting before the tests begin, collect the ice at the latest opportunity and store it in a cool box in the classroom.

The smaller the quantity of ice, the faster the experiment. For example, 1 ice-cube will melt in about an hour, whereas 4 ice- cubes in a funnel take 5-6 hours to melt!

Crushed ice will dissolve more quickly and can be made with an appropriate food blender.

Adding salt at regular intervals makes a marked difference to the results, especially in the funnel test, as a lot of salt drains away during melting.

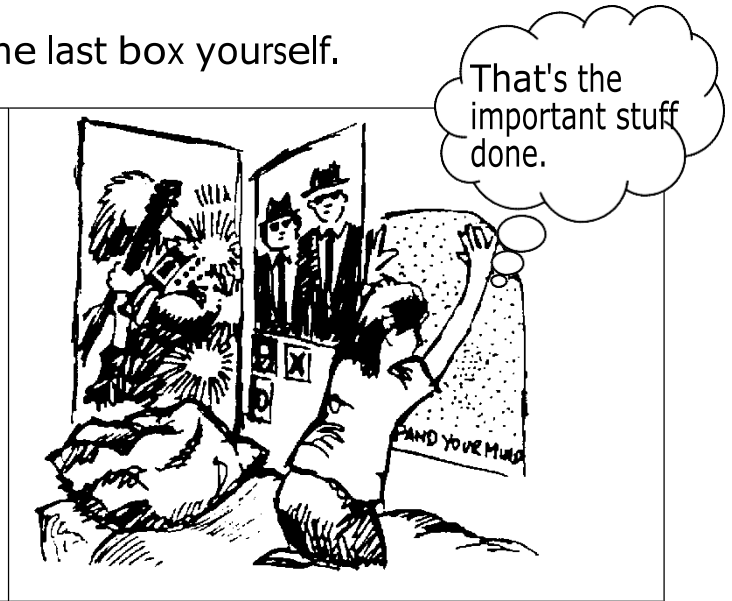
If preparing ice-filled trays, they must be horizontal in the freezer, so the water freezes evenly.

A pinch of salt

Read the cartoon then complete the last box yourself.



Chris has moved to a new house at the top of a steep road.



Chris finishes putting posters on the bedroom walls.



Chris sneaks past Mum, who is on the look-out for 'helpers', and runs into the back yard.



Chris notices a yellow plastic 'bin' outside. It is labelled Salt. He wonders what it is for.



Is it to sprinkle on chips? Or . . .

Icy roads



Plan a test to find an answer to Chris's question.

List what you will need:

How will you make the test fair?

Circle the things you will measure:

time

depth

length

area

volume

mass

force

Circle the ways you will record your results.

bar chart

table

pie chart

line graph

writing

pictures

Draw and label your test:

Ask your teacher if you can start!

Activity 2 Comparing melting with dissolving

Children investigate the difference between melting and dissolving.

Aims

To understand the difference between the processes of melting and dissolving.

To investigate the effect of heat on dissolving.

Resources

- Copies of Activity sheets 2a – 2b
- Salt
- Butter or margarine (small catering pack blocks are ideal)
- Transparent freezer bags
- Transparent and heat-resistant bowl
- Flask of hot water or kettle
- Cold water
- Teaspoons
- Stop clocks or egg-timers
- Transparent containers
- Alcohol-filled thermometers

Dissolving and melting

The introduction to this activity requires the children to follow carefully the instructions on Activity sheets 2a – 2b and complete the relevant sections as the activity progresses. The instructions can be recorded on a voice recorder for children to play back. This will assist those who have reading difficulties or who are visually impaired.

As warm water is used, the teacher may wish to do these activities as a demonstration.

Investigation

In the melting pot

The children are asked to predict what will happen when a sealed bag of salt and a sealed bag of butter are submerged in the hot water. The butter will melt whilst the salt will remain a solid.

Melting can be shown to be reversible when the bag is removed from the hot water and left to cool. The butter will solidify.

In the dissolving pot

This time, add a teaspoon of salt and a teaspoon of butter directly into two bowls of hot water.

First discuss with the children what they predict will happen and then perform the test. Do observations agree with predictions? This procedure is repeated using cold water.

The salt will dissolve and 'disappear' into the water, to form a salt solution. The butter will melt but not dissolve. It will float on the surface of the hot water and solidify if it is cooled sufficiently.

Note that small blocks of butter or margarine (as in catering packs) will dissolve more quickly.

The children should explain their observations and be introduced to the word 'dissolve' if they do not offer this word during discussion.

Children can repeat this test using cold water. The butter will not dissolve but the salt will do so.

With more able children, the teacher can introduce the idea that salt can melt, and ask them to discuss what would be needed to make this happen. Some children may appreciate that much higher temperatures than those achievable in their classroom or home are required for the salt to melt. Salt melts at 801°C.

Safety note

It must be emphasised that children need close adult supervision during this activity.

The temperature of the hot water must be no hotter than 50°C.

Children should be warned of the dangers of burns and scalds.

Reinforcing the concept

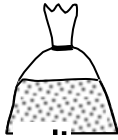
Additional activities may help some children to understand the differences between melting and dissolving. Other substances can be tested in a similar way to salt and wax, and the children make predictions before putting the substances in water.

A range of substances can be investigated to find out which ones dissolve. These substances could include coffee, tea, flour, custard powder, sand, sugar, etc. Substances such as flour and custard powder will be suspended in (floating in the middle of) the water, thus forming a suspension. These substances have not dissolved, as the particles can still be seen in the water. The substances which dissolve cannot be seen, but the solution may change colour.

In the melting pot

Get these things ready:

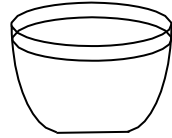
bag of salt



bag of butter



bowl of hot water

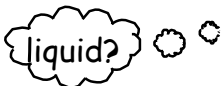


Predict what will happen when the bags are put in the water.

The salt will _____

The butter will _____

Try it.



What does **melting** mean?



In the dissolving pot

Get these things ready:

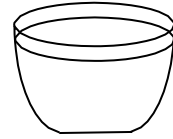
teaspoon
of salt



teaspoon
of butter



bowl of
cold water



Predict what will happen when the butter and salt is tipped in the water.

The salt will _____

The butter will _____

Try it

	<p>Butter</p> <p>Were you right? Explain what happened.</p>
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How can we get the butter back? _____

How can we get the salt back? _____

Explain the **differences** between what happened using hot and cold water:

Activity 3 Salt from salty water

Children see a reversible change as they evaporate water to produce salt from brine.

Aims

To show that salt can be separated from a solution by evaporating the water, leaving salt crystals.

To look at the relationship between evaporation time and surface area.

Resources

- Copies of activity sheets 3a – 3b
- Salt
- Radiator or hair dryer
- Suitable containers such as tea- cup, saucer, egg-cup, plastic plate, yogurt pot

Other resources, depending on the children's planned investigations.

Safety note

All mains electrical appliances used in schools must be checked annually. If a hair-dryer is brought from home, it must go through a standard safety check.

Children should be told not to try this activity at home.

Evaporating

To introduce the concept of evaporation, the children are given Activity sheet 3a and asked what all the pictures have in common. The pictures show wet clothes on a washing-line, a hair-dryer being used to dry wet hair, paintings being left to dry, a draining rack of wet dishes and a towel on a radiator.

Once children have established that each picture shows something drying, they are asked what happens to make wet things dry and where the water goes. The children should be introduced to the word 'evaporation', if it is not suggested as a reason for the water 'disappearing'.

The children are asked to put the examples in order, starting with the one where evaporation (drying) takes the longest. Children may want to introduce factors such as the quantity of water in/on the wet object, the size of the wet object, whether water is trapped inside the object or on the surface, etc. The teacher should avoid introducing these factors, as they can lead to confusion if a child is not ready for them.

During evaporation water changes from a liquid to a gas. Most gases cannot be seen (like air) and so the water seems to have disappeared. The warmer the temperature, the faster the evaporation.

Water evaporates very slowly at temperatures below boiling point. Water molecules (particles) at the surface of the water slowly 'escape' from the water as a gas. Therefore, the greater the surface area exposed to the air, the greater the number of water molecules that escape.

An animation of an industrial brine evaporator can be seen at:
http://www.industry-animated.org/evap_brine.htm

Investigation

Children are given activity sheet 3a, which asks them to obtain salt from salty water in three different ways. Groups of children should decide on appropriate quantities of salt and water, estimate and measure evaporation times, and give reasons for their findings. Teachers can guide children in their decision-making, asking questions such as how long the test will take.

Handy hints

- The smaller the quantity of water used, the quicker it will evaporate. One tablespoon of water in a saucer takes the following approximate times to evaporate: 30 mins with hot air from a hair-dryer blown across the surface, 60-90 mins on a hot radiator, 8+ hours on a sunny window sill in summer.
- The slower the evaporation, the larger the size of the salt crystals. This is demonstrated by using a variety of evaporation methods.
- Using dark-coloured containers aids the observation of the salt crystals.
- When using a hair-dryer, the air should initially be directed across the surface of the water, to avoid blowing water out of the saucer. As the water evaporates, hot air can be blown directly at and closer to the solution.

Water holder investigation

The children then plan an investigation into the effect of the container on the speed of evaporation. They use a tea-cup, saucer, egg-cup and plate and choose additional resources and variables to be controlled and measured. Ideally, they should control the quantity of salt and water and the method of evaporating the water.

This experiment will take 2-3 weeks if the water is left to evaporate at room temperature with no added heat source. However, slow evaporation will produce larger salt crystals.

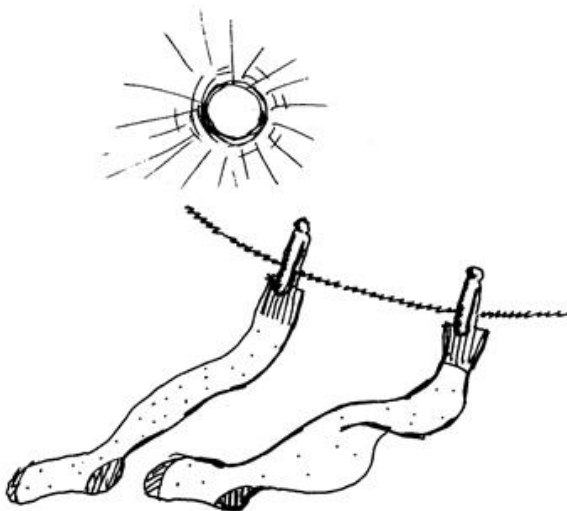
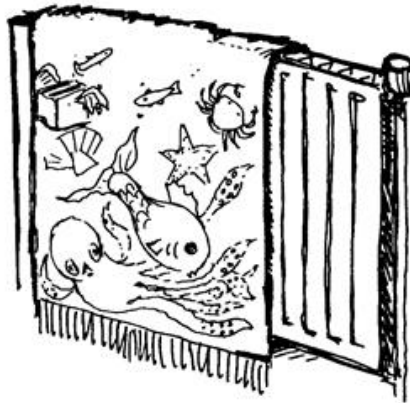
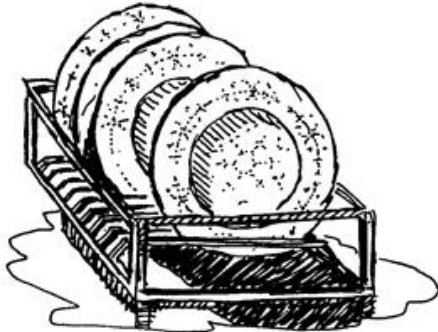
The children should find that the larger the surface area of the exposed solution, the faster the evaporation.

Extension activities

Challenge children to make coloured salt. Salt is dissolved in water with food colouring and then the water is evaporated.

Children can investigate the possibilities of retrieving other solids from solution, e.g. coffee or sugar.

What do they have in common?



Salt from salty water

Think of **three** ways to get salt from a saucer of salty water.

1. _____
2. _____
3. _____

What will you keep the **same** each time? _____

Predict the evaporation time.

1

2

3

Get the salt from the salty water. Measure the evaporation time?

1

2

3

Were you right? Why?

Has the salt evaporated? Why?

Now plan an investigation to find out if the container changes the speed of evaporation. Use the following;

saucer



plastic plate



egg-cup



tea-cup



Remember to make your test fair and reliable

Activity 4 Salt for my chips!

Children purify salt from rock salt using filtration and evaporation.

Aim

To understand that rock salt, used for de-icing roads, contains impurities which can be filtered out of a solution of rock salt.

Resources

- Copies of Activity sheet 4a
- Rock salt
- Table salt
- Magnifiers
- Filter paper or paper towels and funnels
- Transparent containers (e.g. miniature pop-bottles)
- Freezer bags and fasteners
- Rolling pin
- Heat source, e.g. tea-light, hair-dryer or radiator
- Heat stand, sand, foil dish.

Other resources, depending on children's investigations.

Salt from rock salt

Children observe dry rock salt and table salt, preferably with a magnifier, and draw them on activity sheet 4a. Their attention should be drawn to the relative shape, size and colour of the salts. Both types of salt have regular cubic shapes, though the rock salt crystals are larger and coloured and the additional solid impurities can be seen clearly.

The children compare the rock salt and table salt in solution, stirring or shaking a bottle of solution to accelerate the rate of dissolving. They should notice that both salts dissolve, but that rock salt contains solids that do not dissolve, which can be seen at the bottom of the salt solution.

Finally, the children are challenged to "Clean the rock salt so that it is pure enough to sprinkle on chips."

Children should dissolve the salt by adding the rock salt to water. Then filter the solid particles of rock out. The remaining solution contains salt which can be recovered by evaporation.

The challenge is presented on activity sheet 4a with the processes they need to use (not in the correct order). Some processes have been dealt with in previous activities but children may need advice on crushing and filtering. The crushing process accelerates the rate of dissolving. To crush the salt place it in a freezer bag, fasten with a 'twister', and roll with a rolling pin.

From earlier observations the children should appreciate that dissolving rock salt results in other solids being separated from the salt. This solution can be filtered using filter paper or paper towel cones, leaving solids on the filter and a cleaner solution in a fresh container.

If children have access to scales sensitive to a few grams, more able children can be asked to find out how many grams of table salt can be obtained from 50 grams of rock salt?

Recording the activity

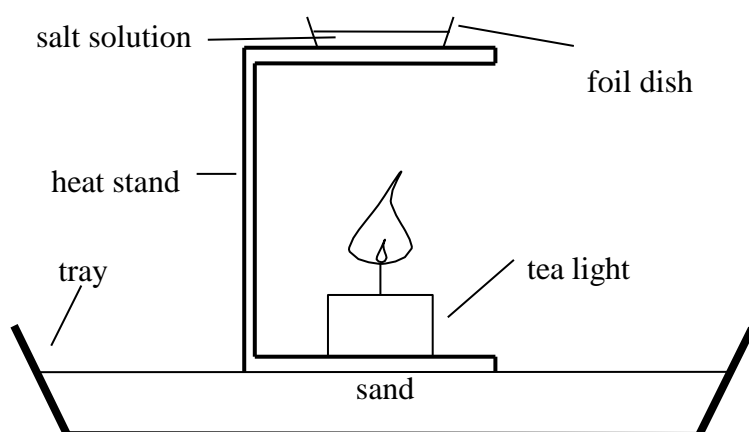
Children produce a step-by-step account in words and pictures of the process they used to obtain 'table salt'. The written account should be limited to 50-100 words, to encourage children to write concisely. The final sample of salt can be displayed alongside commercial table salt, original rock salt, filter residues (which are finer with each filtration), children's work and their equipment.

Handy hints

Use the quickest evaporation method possible, within the constraints of safety and adult supervision levels.

Filtration of a tea-cup of salt solution takes about 15 minutes and evaporation over a cooker hob takes 10-20 minutes. Ledges over hot radiators provide reasonable alternatives, though they will require more time.

Another method that can be employed as shown in the diagram below. Evaporate 1 teaspoon of salt solution in a foil dish using a heat stand and a tea light candle. This method takes 10-15 minutes for 10-15ml.



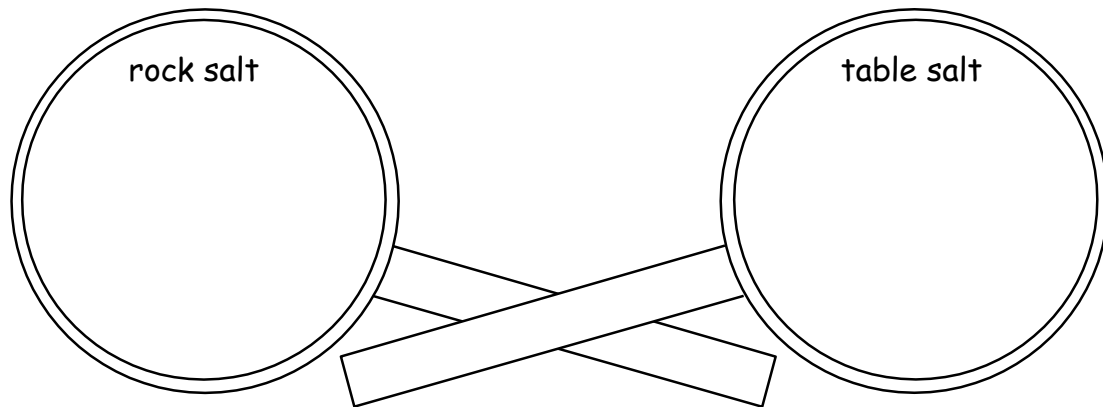
Safety notes

Children require close adult supervision when using heat sources. All mains appliances used in schools must be checked annually. The children should be warned of the dangers of burns and scalds.

If a tea light is used to heat the brine solution, make sure it is removed when the solution has evaporated to no less than half of its original volume. heating the brine until it is dry can cause the hot salt crystals to 'spit' out of the container.

Salt for mychips!

Use a hand lens to look at rock salt and table salt. Draw them carefully.



What is **the same** about them?

What is **different** about them?

Half-fill two bottles with water. Add some rock salt to one bottle and some table salt to the other. What is **the same** and **different** now?

Same: _____

Different: _____



Challenge! Clean the rock salt so it is pure enough to sprinkle on chips.

Clues:

evaporate

crush

stir

filter

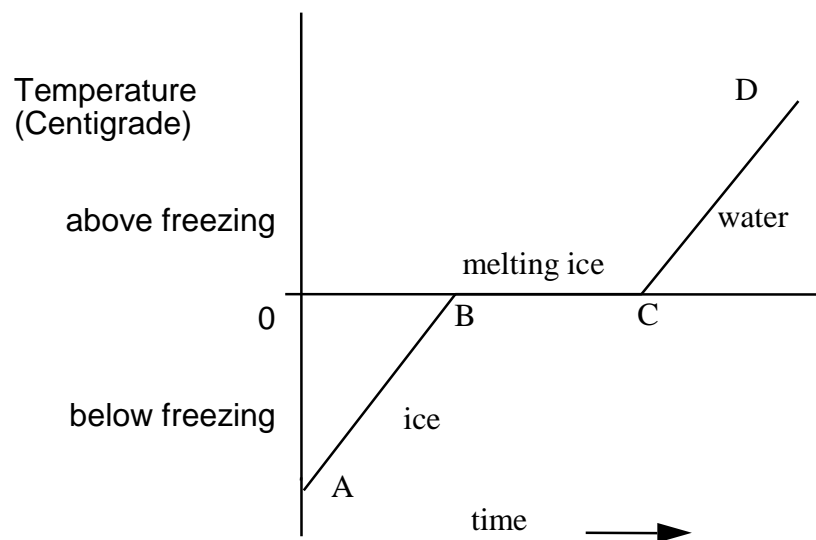
dissolve

Appendix 1: The melting of ice

At low temperatures, water molecules (particles) have so little energy that they cannot move in relation to each other. They are therefore held in a crystalline structure called ice, and the crystalline structure explains the beautiful shapes which some ice particles, particularly snow flakes, possess.

In order to become liquid the molecules must obtain enough energy to break the bonds which hold them in a crystalline structure. When ice warms up, the molecules obtain more energy, begin to move more, break their interconnections and the ice is converted to water. The temperature of the ice and water which it produces remains at 0°C until all the ice is melted.

The melting process is represented by the line B to C in the graph below.



This process is reversed when energy is removed from water by placing it in an environment which is below 0°C (refrigerator freezer compartment).

Normally ice is converted to water by adding energy in the form of heat, but ice can be converted into water by other processes such as compression or by the addition of chemicals such as salt.

Adding salt to ice

The addition of salt to water converts it to brine. Since the freezing point of brine is less than 0°C, frozen water can be converted to liquid brine. In other words, the ice is converted to water without the addition of heat.

Energy is lost, and so the temperature falls. This can be measured by placing a thermometer in the ice-brine solution mixture, to which salt has been added. It may be seen to still be a liquid, even though the temperature is below zero degrees Centigrade.

Appendix 2: Science Investigations - A glossary of terms

This list defines some terms used in the science section of this pack, but is by no means exhaustive.

Planning

The children think about their ideas for 'finding something out'. They use 'talk partners' and group discussion to enable them to share their ideas, asking questions and incorporating knowledge they already have. The teacher can support this process by asking the children specific questions, such as:

What are you trying to find out?

What will you change?

What will you measure, and how?

How will you make the test fair?

How will you record your results?

Their plans can be written, pictorial, recorded on tape, and discussed with the teacher. Often children need to alter their plans during an investigation, as this interaction with materials and equipment provides them with more practical ideas. They should be encouraged to make these changes, whilst considering how the changes will affect other aspects of their investigation, i.e. will the test still be fair?

Prediction

A suggestion about what the outcome of an investigation might be. It need not be specific, and could simply suggest a trend in data.

Question/Hypothesis

A tentative explanation of an observed event. To be scientific, a hypothesis must be testable via prediction and investigation.

Fair test

A test in which all the variables are kept the same, other than the one(s) being investigated. This is to ensure that any observations or measurements made can be attributed to the variable(s) being changed.

Observation

This is the process by which perceptions of objects or events are selected, interpreted, and their significance judged against experience and understanding. Observations can use all the senses, and not just sight.

Factors/Variables

A factor/variable is a quantity that can take different values. It can be categoric, discrete or continuous. Categoric variables could be the colour of a flower or the shape of an object; discrete variables can only be whole numbers, e.g. number of layers of insulation round a cup or seeds germinated; continuous variables can have any value, e.g. weight, volume, temperature or time.

Key factors/variables define the investigation and are either independent or dependent. The independent factor/variable is the one the investigator chooses to change systematically. It is the effect of changing this factor/variable which the investigation is designed to explore, e.g. the presence of salt and its effect on plant growth or the effect of heat on the quantity of salt which dissolves in water i.e. what I will change. The dependent variable is the effect, or that which changes, and is observed or measured. In the examples above, it would be the size of the plant or the amount of dissolved salt in water i.e. what I will measure. The control variables are those which are kept the same, to ensure the validity of the results, to ensure a fair test and the validity of the results. i.e. what I will keep the same.