Science@School Book 6C

Dissolving

Activity worksheets

Peter Riley

1 Teacher's sheet: comprehension

See **pages 4 and 5** of *Dissolving*

Answers

1. **They disappear.**
2. **You could taste it if the sugar had been put in a clean beaker.**
3. **It turns brown.**
4. **The circle should have three kinds of particles arranged at random. There should be a key for the particles such as: w = water, c = coffee and s = sugar.**
5. **A solution.**
6. **(a) food colouring, (b) air.**

Complementary work

(a) If you have talked to the class about the tiny particles being molecules, you may like some of the children to take part in scientific modelling to show how dissolving takes place. Ask four children to hold on to each other. They are four molecules of a solid substance. Ask another four children to form a ring around the group. They are molecules of water. Ask the "water molecules" to pull gently on the "molecules" in the solid. They should not pull them apart. Now ask the solid "molecule" to weaken their hold on each other and ask the "water molecules" to pull again. This time the "molecules" in the solid should be gently separated and gently pulled away from each other by the water molecules.

Teaching notes

When dissolving is first encountered in a science course, some children may confuse it with melting. You may like to refer to this in your introduction to the unit, to make sure the children are aware that dissolving and melting are two different processes. Melting is the change in a solid which results in it turning into a liquid. This occurs at a particular temperature, and solids must be heated for it to occur.

Dissolving is a process in which either a solid, liquid or a gas forms a mixture with a liquid. The mixture is called a solution. This may occur at normal temperatures, such as the temperature of the room. At this stage you do not need to mention the effect of heat on dissolving.

The use of the word 'particle' can cause problems in the study of dissolving and filtering, so it may be useful to explain how the word may be used. In dissolving, the word particle means a piece of matter that is so small that it cannot be seen. By the upper junior stage the children may have come across the words atom or molecule and know that they refer to something that is very small. You can build on this knowledge, if you wish, by saying that the dissolved particles are made up of groups of atoms which make tiny particles called molecules.

In filtering, or in the study of undissolved materials, the tiny pieces of material that can be seen are also called particles. These are made up of large numbers of atoms and molecules that are holding onto each other strongly.

1 Teacher's sheet: activity

Based on **pages 4 and 5** of *Dissolving*

Introducing the activity

(a) If the children have made a model of dissolving in the complementary work, you may like to remind them of how a dissolving liquid pulls the particles of another substance apart. This allows the children to think about dissolving in another way as they make this investigation. You may even ask them which substances they think the water will pull into tiny particles.

Using the sheet

(b) Give out the sheet, let the children fill in their names and form, then go through tasks 1 and 2.

(c) Let the children try task 3. If they need help, remind them of how you introduced the unit with a demonstration of dissolving (see note (i)).

(d) When you have checked and approved the children's work in task 3, let them try tasks 4 and 5.

Completing the activity

(e) Let the children complete tasks 6 and 7 (see note (ii)). In the plenary session let the children discuss the accuracy of their predictions (see note (iii)).

Conclusion

Sugar, salt, coffee grains, bath salts and food colouring all dissolved.

Teaching notes

(i) You may have chosen to introduce the unit by stirring a spoonful of sugar into a clear beaker of water. The children will need to extend this technique a little by measuring out the same volume of liquid for each test. They will also need to use the same volume of solid or liquid substance for dissolving each time. This may be obtained by using a flat spoonful of substance (as opposed to a heaped spoonful, which could be achieved with solid substances, but not liquid substances such as oil and food colouring). The children may also plan to stir each substance a certain number of times in a certain period of time.

(ii) Some children may still need help in extracting data from a table. Task 7 gives all the children an opportunity to do this, so you can identify any who are finding difficulty.

(iii) Look for precision in the answers. Some children may simply say that their prediction skill was "OK", but a more accurate answer should be encouraged, such as "I got eight out of ten correct".

Teacher's sheet: comprehension

See **pages 6 and 7** of *Dissolving*

Answers

1. **The mud is suspended in the water.**
2. **A suspension.**
3. **They will settle out at the bottom of the container.**
4. **A = filter funnel, B = filter paper.**
5. **X = suspended material, Y = cloudy water.**
6. **(a) sand.**

Complementary work

(a) You could show that the particles in a suspension are very small by using a microscope (see teaching notes).

(b) Before you begin the filtering section in the unit in the pupil book, you may like to demonstrate the use of a sieve to clean a mixture of water and sand. You could ask the children to predict what may happen, then show them that the sand and water pass through the sieve. Ask the children how the sand could be removed and look for an answer which suggests using a material with smaller holes. Present the children with filter paper and magnifying glasses and ask them to look for holes. When they have identified the holes, turn back to the unit in the pupil's book and read about filtering.

(c) The children could use secondary sources to find out how dirty water is cleaned at a water treatment plant.

(d) The children could use secondary sources to find out about the problems of obtaining clean water in developing countries.

Teaching notes

If you mixed soil and water as a demonstration at the beginning of the unit, the children should have seen that some parts of the soil float, some sink and some make the water cloudy. Emphasise that the water is cloudy due to tiny particles which have not dissolved in the water. It is not a cloudy colour due to substances that have dissolved in it. The particles which make the water cloudy are so small that they take a long time to fall through the water and settle out.

If the school has a microscope you could use it to show that a drop of suspension does actually contain tiny solid particles. Simply put a drop of the suspension on a microscope slide, put the slide on the stage and look down the microscope. You should make sure that light from a table lamp or the window is shining onto the mirror on the microscope, **but never collect light from the Sun as this can cause severe eye damage**.

Make sure that the children realise that the filter paper only removes the solid particles that can be seen. Clear water that passes through the filter may contain dissolved substances and these may be harmful. Later, in Unit 9, you may return to this point and show that water can be made pure by distillation.

Teacher's sheet: activity

Based on **pages 6 and 7** of *Dissolving*

Introducing the activity

(a) Begin by saying that the solid particles that make water dirty can be removed in two ways.

Using the sheet

(b) Give out the sheet, let the children fill in their names and form then go through tasks 1 and 2.

(c) Let the children work through tasks 1 and 2 (see note (i)).

(d) Go through task 3, then let the children work through it (see note (ii)).

(e) Go through task 4 and make sure that the children can fold the filter paper and insert it in the funnel.

(f) Go through tasks 5 and 6, then let the children work through them (see note (iii)).

Completing the activity

(g) Let the children report on how they performed tasks 4 to 6.

(h) On the following day, let the children complete task 2 and discuss their results.

Conclusion

In beaker A, the suspension may be shown with a little sediment. In beaker B, the suspension should be shown with less shading or dots and a little more sediment. In beaker C, there should be even less suspension (or the water is clear) and more sediment. The children should be able to fold a filter paper and insert it in a funnel. They should be able to see that the filtered soil water is much clearer after filtration.

Teaching notes

(i) You will have to make provision for the children to put their beakers in a place where they will not be disturbed, and for the children to visit them one hour, and one day, later.

(ii) The suspension may be shaded, or it may be shown as tiny dots. The particles of suspension should be labelled.

(iii) The filter funnel can be held over a beaker in a variety of ways. It may be supported by a clamp, boss and stand (available from educational suppliers or borrowed from a secondary school), it may be held in a cardboard support made from an empty cereal packet, or it may be simply held over the beaker in the hand. If the beaker is the right size it can simply be placed in the mouth of the beaker.

Teacher's sheet: comprehension

See **pages 8 and 9** of *Dissolving*

Answers

1. **Soluble.**
2. **Insoluble.**
3. **The oil and water separate. The oil forms a layer on top of the water. They separate because oil does not dissolve in water. Oil is lighter than water and floats on top of it.**
4. **A = stirring rod, B = spoon, C = beaker.**
5. **Undissolved solid.**
6. **For each test, use the same amount of water at the same temperature and make the same number of stirs in the same amount of time.**

Complementary work

(a) Ask the children to compare the solubilities of chemical A, B and C in picture 3 and to make a bar graph of the results for chemicals A, E and F.

Teaching notes

Substances vary in their solubility. Some are not soluble at all. These are called insoluble. Others may have a wide range of solubility, as the chemicals in picture 3 show.

The children may wish to know the names of the chemicals in picture 3. Unfortunately, none of them have common names, but some children enjoy hearing or seeing the names of chemicals. The chemicals in the picture are:

A = potassium permanganate

B = potassium perchlorate

C = potassium dichromate

D = calcium hydroxide

E = iron chloride

F = sodium thiosulphate

The chemical names of salt and bath salts are sodium chloride and sodium carbonate respectively.

When a liquid has become saturated with a soluble substance, no more of the substance will dissolve, and the liquid is said to form a saturated solution. Any extra substance which is added to a saturated solution will fall to the bottom of the beaker and remain undissolved.

3 Teacher's sheet: activity

Based on **pages 8 and 9** of *Dissolving*

Introducing the activity

(a) Show the children some sea salt, table salt, sugar and bath salts. Let each group choose two substances to test. If you have moved directly from the unit in the pupil book, continue to step (b) but if it is a few days since you studied unit 3, read the section on comparing substances with the children again, then close the pupil books.

Using the sheet

(b) Give out the sheet and let the children fill in their name and form then go through tasks 1 to 4.

(c) Let the children try tasks 1 to 4 (see note (i)).

Completing the activity

(d) The children should compare the solubility of the two substances (see notes (ii)).

Conclusion

The solubility of solids can be compared by devising and performing a fair test.

Teaching notes

(i) The children will need a beaker, measuring cylinder, thermometer, stirring rod and spoon (you could use volume spoons, which are available from educational suppliers). The plan should include details of a fair test and mention using the same amount of water at the same temperature in both tests. Both substances should be stirred the same number of times in the same amount of time. The results could be presented as a table with a column for substances and a column for amount of substance dissolved. The units should be in spoonfuls. If you have access to an accurate balance, the children could use grams.

In the plan and in the table look for evidence that the children plan to repeat the experiment to test their results. If there is no evidence for this you may suggest it.

(ii) Sugar and bath salts are more soluble than table salt. Both table salt and bath salts have the same solubility.

Teacher's sheet: comprehension

See **pages 10 and 11** of *Dissolving*

Answers

1. **Particles of the stock cubes have dissolved in the water.**
2. **B is dissolving faster because more of the water around the cube is coloured.**
3. **B.**
4. **Stirring rod with direction arrow, water level, particles spread about in water.**
5. **It removes the stock-rich water from around the cube particles and lets more water take part in dissolving the cube.**
6. **Hot water has more energy than cold water and can pull the stock cube apart faster.**

Complementary work

(a) Make a large cube of Plasticine and ask the children to measure its surface area. Cut the cube in two and ask the children to measure the surface area now.

Cut the cube into four, six and eight smaller cubes. Each time, ask the children to measure the surface area in contact with the air. They should conclude that as the Plasticine is made into smaller pieces its surface area, which is in contact with the air, increases. Apply this conclusion to the breaking up of the stock cube on page 10 of the pupil book.

(b) After the children have tried the practical activity in this unit, you could ask them to devise investigations to find out about the effect of particle size on speed of dissolving, and the effect of stirring on the speed of dissolving. Each group could present a graph of their work and explain what it shows.

Teaching notes

This topic provides a good opportunity for practical work. If the children have been working through the previous units, they may be able to design a fair test which will give you an opportunity to take them further in considering the results.

The data obtained in investigating the effect of temperature is particularly suitable for presenting as a line graph. When this is done, you can show how a line graph can be used to predict results for investigations which have not been tried. It is also important for the children to see how the results from different groups cluster on a class graph and allow you to make a line of best fit. If possible, show how using averages produces even more reliable results.

You may let the children use the experience they have gained in performing the activity to devise investigations, as suggested in complementary activity (b). Time spent on handling results here will be useful for the children both in other scientific topics at this level, and when they move on to secondary science work.

Teacher's sheet: activity

Based on **pages 10 and 11** of *Dissolving*

Introducing the activity

(a) You may introduce the work by demonstrating the experiment on page 11 of the pupil book, on the effect of temperature on solubility. You could then challenge the children to think of how they could find out how sugar dissolves at other temperatures (see note (i)).

Using the sheet

(b) Give out the sheet, let the children fill in their names and form then go through tasks 1 to 6. Return to tasks 1 and 2 to check that the children know what they have to do.

(c) Let the children perform tasks 1 and 2.

(d) When you have checked the plan and the table let the children try tasks 3 to 6.

(e) Give out the graph paper and show the children how to set out the axes for the line graph (see note (ii)).

(f) Let the children make a line graph.

Completing the activity

(g) Draw the axes of the graph on the board. Label the graph A, and plot the results of five groups on it (see note (iii)). Try and work out a line of best fit with the children.

(h) If the children are familiar with the concept of averages, let them calculate the average dissolving time at each temperature for the five groups. Plot the averages on a second graph on the board. Label this graph B. Draw a line of best fit, and show the children how using an average makes the results more reliable (see note (iv)).

Conclusion

The amount of sugar that dissolves in water depends on the temperature of the water. As the temperature of the water rises, its ability to dissolve sugar increases.

Teaching notes

(i) The children may think of putting water in the fridge and they may also suggest using boiling water (which cannot be used for safety reasons). The children may suggest mixing warm and cold water together but if they do not, tell them how this can be done. It is important that, when they have mixed the water to the correct temperature, they use the same volume of it as they have in the tests with water from the fridge and the tap.

(ii) The X axis, or vertical axis, should be used to record the time, in seconds, to dissolve. The Y axis, or horizontal axis, should be used to record the temperature of the water used. You may say that the line graph is more appropriate to use than a bar graph because it can be used to show how the sugar could dissolve at other water temperatures that were not tested.

(iii) Select groups in which there are no anomalous results. Later you could replace one result with an anomalous result to show how it affects graphs A and B. It will show that using an average brings the anomalous result more in line with the other results.

(iv) When using the best fit method in graph A, you may have been able to plot at least two lines, each one at a different angle to the other. In graph B you will have just one line, which may go between the two lines on graph A.

Teacher's sheet: comprehension

See **pages 12 and 13** of *Dissolving*

Answers

1. **(a) rise. The marbles sink to the bottom of the liquid and take up space there. This means that the water must rise above them.**
2. **Same space.**
3. **A felt-tip pen.**
4. **The water is stirred.**
5. **The level is about twice as high as in the beaker on the left.**
6. **It does not dissolve.**

Complementary work

(a) You may wish the children to perform the experiment shown in Picture 3 on page 13.

Teaching notes

Sugar is added to drinks like tea and coffee to sweeten them, and salt is often added to water in cooking. In these two everyday examples of dissolving, people are not usually aware of the increase in volume because it is very small. Sugar is very soluble, and a very large amount has to be added before the volume of liquid changes noticeably, so someone who likes a lot of sugar in their drink, even as much as four spoonfuls, will not see their drink increasing in size. Salt is much less soluble in water, so the liquid does not greatly increase in volume when it is saturated. You may wish to mention these facts if the children seem amazed that dissolving increases volume and they say that they have not seen it.

Teacher's sheet: activity

Based on **pages 12 and 13** of *Dissolving*

Introducing the activity

(a) Read through the sugar cube test on pages 12 and 13 of the pupil book. Some of the children may be surprised to find that the volume of a liquid increases when a substance dissolves in it and will be keen to test this information. Build on this by asking them to predict how many sugar cubes they think are needed to see that the level of the liquid has risen.

Using the sheet

(b) Give out the sheet, let the children fill in their names and form and go through tasks 1 to 8 (see note (i)).

(c) Let the children carry out tasks 1 to 4 and check their work.

(d) Let the children carry out tasks 5 to 8 (see note (ii)).

Completing the activity

(e) Let the children compare the prediction with the result and assess their accuracy. They may like to compare their predicting ability here with other activities in which they have made predictions and evaluated them.

(f) You may say that when a discovery is made, the scientists who make it write a report and it is published. Other scientists then read the report and repeat the experiment to see if they get the same results. The children have behaved like scientists by reading about the experiment in the pupil book and then repeating it to see if they reach the same conclusion (see note (iii)).

Conclusion

When sugar cubes are added to water the volume of the liquid increases.

Teaching notes

(i) The volume of water is deliberately not specified so that the children can make a choice. In order to prevent huge numbers of sugar cubes being used, you can instruct the children to choose small volumes of less than $50cm^3$.

(ii) It is important to keep particularly vigilant in this activity as sugar cubes can become small missiles. There may also be some over-enthusiastic stirring as the children try to reach their predictions.

(iii) Some children may ask what happens if other scientists get different results from the first group of scientists. When this happens, the first group of scientists may read the results of the others and repeat their own work to try and find why there is a difference. When differences occur, sometimes new discoveries are made, but sometimes the difference is due to the investigation plan not being thorough enough or to mistakes being made when the practical work is being done.

Teacher's sheet: comprehension

See **pages 14 and 15** of *Dissolving*

Answers

1. **The bottle should have bubbles in it labelled air. The water in the bottle should also be labelled.**
2. **Some of the air that was dissolved in the water came out of the water and formed bubbles.**
3. **At the surfaces of oceans, lakes or rivers.**
4. **(c). Most of the air is driven out when the water first boils, so there is less to escape later. However, if you do this, it appears as though the bubbles form slowly as the water first comes to a boil, then speed up.**
5. **Carbon dioxide.**
6. **(a) It goes down, or decreases;**
   (b) The liquid cannot hold as much dissolved gas, so the gas forms bubbles and escapes.

Complementary work

(a) The children can make a survey of fizzy drinks and find out what other substances are dissolved in them. In the survey, they should mention the flavours of the drinks, and the type of containers used to store the drinks. They should also examine non-fizzy drinks to discover their flavours and packaging.

Teaching notes

As the children spend a great deal of time investigating how solids dissolve, some of them may be surprised that gases also dissolve in liquid and they may ponder how this can happen. Air, which is a mixture of gases, dissolves in water through the water surface. If air did not dissolve in water, then many kinds of water life could not survive. For example, fish have organs called gills which take in oxygen dissolved in the water. In places where the water surface is large, the amount of air entering the water will also be large.

Similarly, as river water splashes over rocks, the surface area of the water is increased and the amount of air entering it is also increased. This means that in streams and rivers high in the hills, the oxygen content of the water is higher than in water lower down, where there are fewer rocks to cause splashing. Also, water higher in the hills is colder than water lower down, and this also helps the water to take in more gas.

You may find it necessary to emphasize that gases dissolve better in a cold liquid than a warm one, and compare this with solids, which dissolve better in a warm liquid than a cold one.

Large amounts of carbon dioxide can be dissolved in water by increasing the pressure on the gas. This forces the gas into the liquid, where it remains dissolved until the pressure is taken off. When a gas is stored under pressure, it is held in a strong metal container. Some children may be aware of this if they have a carbonated drinks maker at home, which uses a canister of carbon dioxide to make the drinks fizzy.

6

Teacher's sheet: activity

Based on **pages 14 and 15** of *Dissolving*

Introducing the activity

(a) Ask the children to predict what might happen if they warmed up a fizzy drink. Do they think that warming speeds up fizziness or slows it down (see note (i))?

Using the sheet

(b) Give the children the sheet, let them write their names and form on it then go through tasks 1 to 5 with them (see note (ii)).

(c) Let the children carry out tasks 1 to 4 (see note (iii)).

(d) Let the children carry out task 5 (see note (iv)).

(e) Let the children carry out task 6 (see note (v)).

Completing the activity

(f) The children could compare their observations and explanations.

(g) The experiment could be repeated with clean drinking glasses, and each drink could be tasted at the end of the experiment (see note (vi)).

Conclusion

The bubbles escape more quickly from the warm fizzy drink because carbon dioxide dissolves less easily in the warm water than in the cold water.

Teaching notes

(i) As fizzy drinks are usually cooled to make them really refreshing, the children may think that coldness makes them fizzier.

(ii) Take care to offer the children water which is warm but not hot.

(iii) The children should look carefully into the top of each beaker. It may help them if they count the number of bubbles escaping from each water surface over a time period of ten or fifteen seconds. They may also look at the size of the bubbles being formed and escaping.

(iv) The children should see that more bubbles are produced in the fizzy drink in the bowl of warm water, and that many of these bubbles are larger than the bubbles in the fizzy drink in the bowl of cold water. Streams of small bubbles may form in the drink in the bowl of warm water.

(v) The explanation should state that more bubbles escape from the warm drink because the gas does not dissolve as easily in the warm liquid as in the cold.

(vi) The children will find that the drink in the bowl of warm water tastes flat while the other drink is still carbonated.

Teacher's sheet: comprehension

See **pages 16 and 17** of *Dissolving*

Answers

1. **A mixture of solids dissolved in water.**
2. **A substance that has small connecting holes in it.**
3. **Filter paper.**
4. **The diagram should show an inverted cone in a saucer of water. There should be two ink spots on the paper, both at the same height above the water. The filter paper, saucer, water and ink spots should be labelled.**
5. **The water rises up the filter paper and carries the different coloured particles in the ink to different heights up the paper.**
6. **Paper chromatography.**

Complementary work

(a) The activity on page 44 can be repeated using food colourings instead of inks.

(b) The activity on page 44 can also be repeated with newspaper and blotting paper, as well as filter paper, to compare how the different papers separate the substances in inks and food colourings.

Teaching notes

Paper chromatography is a popular topic and the children may have already used this technique before. If they have, ask them to describe their experiences as you introduce the unit. The chances are that the children will talk about their amazement at how there may be a range of different colours in one ink. You should acknowledge this, then let them focus on making a fair test in the activities associated with this unit.

Paper chromatography works because the different dyes used to make up each colour have different solubilities and different weights. The lighter, more soluble dyes will travel faster up the paper, while the heavier and less soluble dyes travel slower. Over time, the different dyes will separate from each other.

Teacher's sheet: activity

Based on **pages 16 and 17** of *Dissolving*

Introducing the activity

(a) Remind the children of your introductory demonstration, in which you wrote a name on filter paper and then dipped the lower end in water. Write a name, using a different coloured ink for each letter. Ask the children what might happen if you dipped the lower edge of the paper in water. Ask the children how you could make this investigation more scientific (see note (i)).

Using the sheet

(b) Give out the sheet and let the children fill in their names and form then go through tasks 1 to 3 (see note (ii)).

(c) Let the children perform tasks 1 to 3.

(d) Let the children carry out the investigation and then try task 4 (see note (iii)).

Completing the activity

(e) The children can report on their findings to the whole class.

Conclusion

A water-based ink may be made from a number of different coloured substances. They can be separated by water seeping through filter paper. Some of the coloured substances are not the colour of the ink.

Teaching notes

(i) The children may predict that the ink used for each letter may separate into a range of colours. You may dip the paper in the water and let them see their prediction confirmed. The children should say that in order to make the investigation more scientific, one dot of each ink should be used and all the dots should be the same distance from the edge of the paper.

(ii) You may cut the strips up for the children. The strips should be about 3cm wide and 10cm long, depending on the other resources you use. You can make them smaller than this. With more able children you may let them chose the dimensions of their paper strips and let them cut the strips accordingly. The size of the strips can be assessed for their appropriateness for the task.

(iii) A ruler should be used to measure 2cm, or 3cm, from one end of the paper. A line may be made at this distance, and an ink spot made on the line in the middle of the paper strip. The water level in the beaker should be between the bottom of the paper and the spot. This ensures that when the paper is placed in the beaker, the water is below the ink spot and can seep up the paper towards it.

Some children may suggest leaving the paper in the beaker for a certain amount of time. Other children may suggest leaving the paper in the beaker until the water has reached a certain height. Both are acceptable.

Teacher's sheet: comprehension

See **pages 18 and 19** of *Dissolving*

Answers

1. **The solid breaks up into particles which are too small to be seen.**
2. **As much as the water will take until no more will dissolve.**
3. **The small crystal you use to grow a large one.**
4. **A larger crystal should be drawn around the seed crystal.**
5. **It would have a flat base and would only grow upwards.**
6. **Leave it undisturbed for a few days, or even weeks.**

Complementary work

(a) The following substances can be used for growing crystals. All these substances must be used with care and a risk assessment must be made before use. If the children conduct the experiment, close adult supervision is necessary. The substances are: chrome alum (purple), copper sulphate (blue), ferrous sulphate (green), potash alum (white).

The crystal which is suspended in a saturated solution is called a seed crystal. You can make seed crystals in the following way. Dissolve some of the substance in warm water and make a saturated solution. Let the solution cool and crystals will form. Select the largest crystal, one you can tie a thread around easily. Then follow the instructions on page 19 of the pupil book.

Teaching notes

Children find crystals fascinating, so it can be worth spending some time looking at geological specimens of crystals and talking about how they form. When molten rocks cool down, they form crystals called minerals. Each mineral is made from one or more chemicals.

If you have used scientific modelling earlier, you may like to refer to it again and say that the atoms of the chemicals can arrange themselves in a certain orderly way. When they do this, they form crystals with distinctive shapes. Salt, for example, is made of two chemicals – sodium and chlorine. The atoms of these two substances arrange themselves so that they form crystals which are cube shaped.

When crystals are grown from saturated solutions, the atoms of the chemicals of the dissolved substance arrange themselves in an orderly way around the seed crystal. If you wish to grow a fine crystal, you must select a seed crystal with a good shape on which the atoms of the other substance can settle and organise themselves.

Crystal growing, in both the complementary and supporting activities, gives the children an opportunity to handle chemicals. You must make sure that they know that they must not taste the chemicals and must follow all school policies associated with the handling of chemicals.

8 Teacher's sheet: activity

Based on **pages 18 and 19** of *Dissolving*

Introducing the activity

(a) Tell the children that there are many processes that are used to investigate materials and some of them need special care (see note (i)). The activity they will try here requires the children to take a great deal of care. They are going to heat a substance and observe it while wearing eye protection.

Using the sheet

(b) Give out the sheet and let the children fill in their names and form then go through tasks 1 to 7.

(c) Let the children try tasks 1 and 2 (see note (ii)).

(d) Make sure the children wear eye protection that is in accordance with your school policies.

(e) Place a night light candle in a sand tray and light it. Let the children perform tasks 3 and 4 group by group. Stay with each group as they heat their spoon. Make sure that the children are standing up as they heat the spoon (see note (iii)).

(f) Let the children complete tasks 5 to 7 (see note (iv)).

Completing the activity

(g) Let the children report on what they saw.

(h) Ask the children why the crystals formed so quickly (see note (v)).

Conclusion

When a saturated solution of Epsom salts is warmed for a minute, enough water escapes to make it impossible for all the dissolved substance to remain in solution, so some of the substance forms crystals.

Teaching notes

(i) Sometimes older children ask if everything is found out by just making observations or by using only simple processes such as filtering. They may have seen a more complicated process on the television and ask why they cannot try something similar. This activity allows them to use heat. It also gives you an opportunity to discuss safety issues and assess the children's maturity and responsibility in practical work.

(ii) Use only a small volume of water as Epsom salt is quite soluble. You may like to use just one solution for all class groups. It may help the children if they use a ruler to draw on paper an area about 2cm long and 1cm wide.

(iii) Make sure that the night light candle is in the centre of the sand tray, and that the children are standing up so that it is easier for them to move away if an accident happens. The spoon should be a metal teaspoon with a wooden handle or, if the spoon has a metal handle, the child could wear an oven glove.

(iv) Make sure the group can see a clock or timer. They must remove the spoon from above the flame after one minute. The children can move away from the sand tray to complete their observations. They must take care not to let the hot spoon touch their hands. They should find that after two minutes, diamond-shaped crystals begin to form at different places in the liquid. More crystals will then grow very quickly across the surface of the liquid, and soon the whole surface will be covered in crystals. Crystallisation really does take place before their eyes, and many children may want to try the activity again.

(v) Heating the saturated solution removes water and makes the liquid too concentrated to hold all of the Epsom salts in solution, so some salt comes out of solution and forms crystals. If the children are interested in chemical names, you can tell them that Epsom salts are made from the chemical magnesium sulphate.

Teacher's sheet: comprehension

See **pages 20 and 21** of *Dissolving*

Answers

1. **The particles of the dissolved solid are so small that they pass through the holes of the filter paper with the water.**

2. **Warm, dry, moving air.**

3. **The warmer it is, the more energy there is for the water to change from a liquid to a gas.**

4. **Yes. Boiling is a fast form of evaporation.**

5. **A = Boiling water, B = Rising steam, C = Condensed water, D = Distilled water.**

6. **The X should be at the bottom of the container holding the boiling water.**

Complementary work

(a) You could demonstrate how salt and water can be separated by boiling in the following way: Make a salt solution. Put a night light candle in a sand tray and light it. Pour some of the salt solution into a metal soup spoon. Hold the spoon about two centimetres above the candle flame. Hold a second metal soup spoon about three centimetres above the first. Hold the spoons in position for a few minutes then turn over the upper spoon to show the condensation. You may not need to wear oven gloves for this demonstration, instead, you could use metal spoons with wooden handles.

Teaching notes

This unit may be used in sequence, as it appears here, or straight after Unit 2. In Unit 2 water is mixed both with substances that dissolve in water, and with substances that do not dissolve in it. The process of separation is also discussed in Unit 2, and undissolved substances are separated from the water and from the dissolved substances. This unit takes the separation a stage further by showing two techniques for separating a dissolved substance – evaporation and boiling.

You can also use this unit when you are studying the water cycle, as both evaporation and condensation are covered here. The application of evaporation in extracting salt from sea water, as discussed here, can be mentioned when you consider evaporation of water from the sea as part of the water cycle.

Teacher's sheet: activity

Introducing the activity

(a) Show the children the liquids labelled A to F (see note (i)) and tell them that some liquids contain dissolved substances and others do not.

Using the sheet

(b) Give out the sheet and let the children write their names and form then go through tasks 1 to 3.

(c) Let the children complete tasks 1 to 3.

(d) Go through tasks 4 to 6 (see note (ii)) then let the children try them.

(e) Let the children try tasks 7 and 8 (see note (iii)).

Completing the activity

(f) Let the children compare their results.

Conclusion

Substances are left behind when liquids B, C, D and E have evaporated. Liquid A will probably not show any dissolved substances, and liquid F will not show any dissolved substances (see note (iv)).

Teaching notes

(i) A is tap water, B is blue and contains bath salts, C contains salt water, D contains ink, E is the filtered soil water from Activity 2, F is distilled water (obtainable from a secondary school science department or a chemist).

(ii) You may like to ask the children the reason for their predictions. They may say that some dissolved substances colour the water so they are easy to identify.

The plan should state that equal volumes of the liquids are set out on dishes or trays and left in a warm place to speed up evaporation. If a liquid contained something dissolved in it, that substance would be left behind after the water had evaporated and will be easy to see.

The explanation for why the plan will work should include that water evaporates in warm conditions, but the dissolved substance cannot evaporate and will remain behind.

(iii) The investigation will take a few days to complete. The dishes of liquid must be left undisturbed in a warm place during this time.

(iv) Tap water does contain dissolved substances, but these may not be seen due to the small amount of water used in the investigation.

Teacher's sheet: comprehension

See **pages 22 and 23** of *Dissolving*

Answers

1. **Millions of years.**
2. **Try and make a soapy lather with the water. The soap does not make much lather with hard water. It may make a scum.**
3. **Stalactites should be labelled and shown growing from the cave roof. The stalagmites should be labelled and shown growing from the cave floor.**
4. **Limestone.**
5. **Limestone is less soluble in hot water than cold water.**
6. **A water softener.**

Complementary work

(a) The children can research, using secondary sources, to find out about limestone caves and large stalactites and stalagmites.

(b) If you can find a secure place to display the growth of washing soda stalactites and stalagmites, then you may wish to set up the following demonstration: Make a saturated solution of washing soda and pour equal amounts into two jars or beakers. Place a length of thick, woollen thread, or yarn, between the beakers, so that each end is in one beaker and the thread dips a little in the middle to form a U-shape between them. Place a deep dish below the U-shaped piece of thread. For more details, see the teaching notes on this page.

Teaching notes

It is customary to describe limestone as dissolved in water. However, although the dissolving property of water is important, the processes are more complex.

Limestone dissolves in water due to the chemical and solvent properties of water. Carbon dioxide in the air dissolves in rainwater. This produces a chemical change in the water that turns the water into a weak acid. This weak acid reacts with the substance from which limestone is made, calcium carbonate. The acid changes calcium carbonate into calcium bicarbonate, which dissolves in water.

When water rich in calcium bicarbonate reaches the roof of a cave, drops fall to the floor. When a drop falls, it releases carbon dioxide back into the air. This causes tiny particles of calcium carbonate to re-form. Those particles which stay on the cave roof stick together and form a stalactite. Those which fall to the cave floor stick together and form stalagmites. If the children have studied chemical change, and have sufficient interest or ability, you may use this information as an example of chemical change, as well as an example of dissolving.

If you plan to try complementary activity (b), you will find that the washing soda solution moves through the wool thread and drips from the bottom of the U-shape. A stalactite will grow at the bottom of the U, and a stalagmite will grow in the dish beneath it. The process may take a few days. You may be able to measure the length of the stalactite and stalagmite each day, and calculate its rate of growth. The growth of real stalactites and stalagmites is much slower.

10 Teacher's sheet: activity

Based on **pages 22 and 23** of *Dissolving*

Introducing the activity

(a) Begin by reminding the children that when limestone is dissolved, a substance called calcium is dissolved in the water. This substance makes it difficult for the water to make a lather with soap. It can also make the water produce a cloudy scum. Tell the children that they have three waters to test, and they are going to use bath salts instead of soap to test for hardness (see note (i)).

Using the sheet

(b) Give out the sheet and let the children fill in their names and form then go through tasks 1 to 6 (see note (ii)).

(c) Let the children try tasks 1 to 6.

(d) Give the children the concentrations of calcium in the three water samples. Do not give them in the order A, B and C.

(e) Let the children try tasks 4 to 6.

(f) Let the children try tasks 7 and 8.

Completing the activity

(g) Let the children report on their findings and compare results.

Conclusion

Water rich in calcium will not produce a lather with bath salts but may produce a cloudy scum. Water which has only a small amount of calcium in it will produce a lather and no scum. The amount of calcium in the water affects the ability of the water to make a lather. The more calcium the water possesses the less able it is to make a lather and the more likely it is that the water will make scum.

Teaching notes

(i) If you live in a hard water area, you may wish to use the local water and softer, bottled, mineral water. In order to complete the activity, you will need to know the concentration of calcium in mg/l (milligrams per litre) from your local water company. You may, however, prefer to use bottled water as suggested for people who live in soft water areas.

If you live in a soft water area you can obtain hard water from bottled still mineral waters which have added calcium. This can then be used with two other still mineral waters with differing amounts of calcium. For example, when waters with 300, 78 and 9 mg/l of calcium were each tested with bath salts, the first water went cloudy and produced no lather, the second was clear at first with some lather and the third was clear all the time and produced the most. After five minutes the second water sample became cloudy, but not as cloudy as the first water sample.

(ii) Use small amounts of water. For example, about $25cm^3$.