2. Extracting the active ingredient

1 ½ hours

The children face the challenge of separating crystals of salt from waste materials using dissolving and evaporating techniques.

OBJECTIVES

- To separate soluble and insoluble materials by dissolving and filtering.
- To know that you can recover a solid from a solution by evaporating water.
- To select suitable equipment for the task from a range of options.

RESOURCES

(Per group of 2-4 children, unless otherwise stated)

- Activity sheets 5-8
- Hand lenses
- Petri dish (or similar shallow dish)
- Powder samples[1]
- Filter paper
- Funnel
- 2 Beakers or yoghurt pots
- Teaspoon or stirrer
- Water (200 ml approx.)
- Tall collecting vessel
- Disposable/protective gloves
- Digital camera (optional)
- Digital microscope (optional)

INTRODUCING THE ACTIVITY

Read the letter from Pets Paws plc, a company developing a new pet medicine (Activity sheet 5). It explains that the company have identified the active ingredient and have provided a sample in an impure form. The children's task is to separate the active ingredient from the mixture.

1 Mix 3 heaped tablespoons of dry, soluble material (e.g. Epsom salts, table salt) with 3 heaped tablespoons of dry, insoluble material (e.g. chalk dust, sand).

Ask the children if there are any words that they would like help with. Gather the children's ideas for words and phrases such as:

- Laboratory
- Active ingredient
- Crystal
- Waste material
- Separate

Display these words and include the children's definitions.

Provide pairs or groups of 4 children with their powder samples. Children should wear protective gloves to carry out the 'finger test', a test often used in industry to compare the textures of different powders. Children rub the mixture between their fingers to feel the texture.

Using hand lenses or a digital microscope, children observe the mixture. Digital images can be displayed on an interactive white board. The children can then draw and label what they observe (texture, colour, particle size and shape etc). The children could take digital images of the dry mixture to compare with the pure substance at the end of the process in Activity 3, *Mixing the medicine*. The children can record their observations at the top of Activity sheet 6 (the rest of this sheet is used in Activity 3).

Ask the children to discuss their observations and thoughts about the mixtures. You may list the following questions on the board as discussion prompts:

- How many different materials can you see?
- How do you know they are different?

There are at least two different types of particle in the mixture. Some are different colours. The bits are different sizes. Some bits are shiny and some are dull.

Describe the appearance of the active ingredient (shiny crystals - salt, or Epsom salts), but they are mixed with materials that they do not want (waste materials or impurities).

- How could you separate the crystals from the other waste materials?

Children should consider different methods to extract the active ingredient from the sample (such as sieve it, wash it with water, pick out the active ingredient with tweezers etc). They could use Activity sheet 7 to prompt their discussion, allowing them to make their own suggestions.

MAIN ACTIVITY

Discuss different ideas and identify an extraction process or allow them to carry out the process they decide on from Activity sheet 7. More able children could plan their investigation independently.

Using the sample from *Pets Paws plc*, the children add water a teaspoon at a time and stir until all the white crystals have dissolved. The aim is to make a solution near to saturation to produce crystals quickly. To achieve this, the children can be asked to add *just enough* water for the crystals to dissolve, and no more.

Display the following discussion questions and ask the groups to feedback:

- What do you notice happens to the white crystals (active ingredient) when water is added?

They have dissolved which means that they have changed into tiny little pieces that are too small to see.

- What happens to the other material (sand or chalk) when water is added?

It has made the mixture 'cloudy' and eventually settles at the bottom of the container. It is insoluble and therefore will not dissolve in water; it does not break into tiny pieces.

- How do we know they haven't completely disappeared?

Discuss examples of where a dissolved material changes the colour of a solution, e.g. instant coffee granules, or brown sugar. The change of colour shows that the dissolved material is still in the solution.

Following subsequent evaporation of the water from the solution, the children will see that the crystals were there all the time.

- How can scientists tell if a substance is pure?

The ingredients for making medicines must be very pure. Even if they look pure, companies need to carry out tests on every batch that comes into the stores. The scientists use special equipment that shows them if there are any unwanted ingredients in the medicine.

The children can now separate the material that has not dissolved from the solution, using a filter paper that acts like a very fine sieve. You could show a filter paper under the digital microscope to show the holes.

Demonstrate how to fold a filter paper or paper towels into a cone (e.g. fold in half, then in half again, and open out one fold to make a conical shape). Ask the children to do it, place it in a funnel and put the funnel into a tall container, such as a measuring cylinder, to collect the filtrate (the 'stuff' left behind after the insoluble solid has been removed). Explain that the children should pour a small amount at a time of the mixture into the filter paper, as it drips through slowly. Otherwise, the insoluble material can run down the outside of the filter paper. Care must also be taken not to tear the paper, as the insoluble chalk or sand will go through the holes. Children should not touch the paper once it is wet.

When the children have a pure solution, ask questions like:

- Now we have filtered the solution, how can we get the active ingredient back?

By allowing the water to evaporate (turn into a vapour), leaving the crystals behind.

- What is evaporation? When does evaporation happen?

It is when a liquid changes state into a gas e.g. water changes to water vapour.

- Where does the water go?

Into the air around us.

- Where else can they think of examples of evaporation?

Puddles drying, drying towels or clothes on the washing line, tumble driers, the water cycle, out of the kettle as it heats up and boils.

Ask the children to pour a small amount of the solution into a Petri dish or shallow tray/dish and put in a cool place to evaporate the water very slowly (the slower the evaporation, the bigger the crystals, hence a cool rather than warm location). Using shallow, black plastic food trays will give the crystals a contrasting background to make them easier to see. You could choose to allow the children to investigate which conditions allow the biggest crystals to be formed.

Ensure that children label their experiments.

The crystals should have begun to form the next day, and all the water should evaporate after 2-3 days.

Encourage the children to observe the crystals formed using hand lenses and/or the digital microscope. They can compare the new crystals with those that were seen in the mixture. Copies of Activity sheet 8 can be shared with the class, which shows two types of salt crystals at a higher magnification than they might be able to see in the classroom.

PLENARY

Ask children to report their findings to the company, describing the extraction process and their observations. This can be done by making a scrapbook of digital photographs taken during the sessions, which the children annotate. They can write the captions, comments, headings or speech bubbles to give further information. Provide key vocabulary (on classroom displays, word cards, class dictionaries, etc.) including mixture, dissolve, filter, evaporate. Ask the children to feedback to the class their ideas about the processes.

Explain to the children that the active ingredient is what helps the dog to get better. This can be found naturally as a mixture with other materials. The active ingredient must be extracted from the mixture before it can be used to make a tablet.

EXTENSION

The questions below can be used to extend the work with more able children, or with Year 5-6 children in mixed classes:

- Why have we put the solution into a flat dish and not left it in the tall measuring cylinder?

Children can investigate the relationship between surface area and evaporation.

- How can we speed up or slow down evaporation (to get smaller or bigger crystals)?

By heating or cooling the solution. Explain that water changes into water vapour quicker the hotter it is, and that the quicker the water evaporates, the smaller the crystals that are formed. In industry, they will vary the temperature to form crystals of the sizes they require and will monitor and regulate it in order to produce uniform crystals.