

SEPARATING MIXTURES

Science background for teachers

VOCABULARY

Mixture, solution, solid, liquid, separating, sieving, filtering, decanting, evaporating, condensing, distilling, chemical, industry, retrieved, process, vapour, sediment, soluble, insoluble

A mixture is formed when two or more substances are mixed physically and not chemically combined. These substances can be separated and recovered again by physical and not chemical means, although not always easily. The method of separating may depend on the sizes of the particles involved or on their physical properties. Examples may include sieving, decanting, filtering, evaporating, distilling and chromatography.

Very young children experience sieving when they play with sand and water and all children see it in everyday contexts with tea strainers, tea bags, coffee pots and straining water and vegetables with a sieve or colander.

Sieving involves smaller particles in a mixture passing through holes, whilst the larger particles remain behind in the sieve. Sieves of different grades can be used to separate out particles of different sizes. Anything with holes or slits can be used to sieve. Children can invent their own sieves to suit their purpose.

Straining involves separating solid in liquid mixtures where the solid particles are large, such as vegetables in water, where you want to retrieve the solid.

Filtering is generally used to separate liquid from smaller solid particles where the holes in the smallest of strainers are still too large. Filtering uses special **filter paper**, which allows the liquid through but catches the very small solid particles. Other materials such as gravel and charcoal may also be used as filters to trap tiny solid particles. They are used in industries such as the water industry for cleaning wastewater where paper is obviously not practical.

Leaving a mixture to stand then pouring the liquid carefully off is called **decanting**. This may be done to wines to leave behind the sediment, but is not often mentioned and is a valuable process to demonstrate with children. This may be seen in the traditional coffee-making method (not instant) where the coffee and hot water are left in a jug to stand and the coffee is decanted off, similarly with making tea in a teapot. The coffee grounds and tea leaves sink to the bottom in a matter of minutes and a strainer is only needed as the pot is tipped more. If a mixture of soil and water are left to stand, the water that is obtained by pouring off the top layer is very clear, but some water remains behind in the soil, which can be filtered. Children can experiment with a variety of different filters, some of which are used in industry eg gravel and sand.

Tip wash the gravel/sand first or they make the water dirtier!

Magnetic materials (nickel, cobalt and iron including its alloys such as steel) may also be separated from non-magnetic materials such as plastics or aluminium using a magnet. This is useful in the scrap metal industry. Take care when choosing metal objects to use, many these days contain steel and are coated with a brass lacquer, such as brass tacks. They are magnetic even though brass is not.

Evaporating the liquid

The **filtering process** will not separate a true solution because the solid breaks down into particles so small they will pass through filter paper and these are dispersed evenly in the liquid. The particles of the solid then form weak interactions with the molecules of the liquid. If the solution is heated, the heat energy is enough to break the interactions. The liquid evaporates leaving the solid behind. This will also happen without heat, but takes much longer. This will retrieve the solid, but the liquid will be 'lost' as a vapour. To recover the liquid, the vapour is collected, cooled and condensed and this process is called **distillation**. In countries where there is a shortage of clean drinking water, this may be obtained by heating seawater, the vapour is then cooled and the result is pure water. The recovered salt is also used.

Salt is obtained on a large scale from either evaporating seawater or from the ground. Sea salt is used primarily for cooking and is produced in relatively small quantities. The chemical industry uses salt in larger quantities and obtains it from the ground in one of two ways. It is either mined by cutting, drilling and blasting the rock or more commonly by pumping water down into the rock where it dissolves and is brought to the surface as brine (salty water).

Chromatography This literally means 'writing with colour' and is a technique used to separate solutions where more than one solute (solid) is dissolved in the solvent (liquid). For example colours and dyes are often made up of various components to obtain one colour. These can be separated out into the different components using chromatography. A spot of the solution to be separated is put onto absorbent paper, a solvent (water if the solute is water-soluble) is allowed to be absorbed onto the paper. As it spreads through the paper the components of the solution separate out through the paper at different speeds because they are attracted to the paper fibres to different degrees. Thus the colour components of a dye will separate out. Sometimes the components will not separate by this method. This may be because they are not soluble in the solvent that is being used, it is necessary to test them before the children try the activity. Not all water-soluble inks and fibre tip pens will separate into component colours using only water as the solvent. Many of the colours in a tube of 'Smarties', often used in the past for this activity, will no longer separate out with water! Water-soluble drawing inks and overhead projector pens work well.

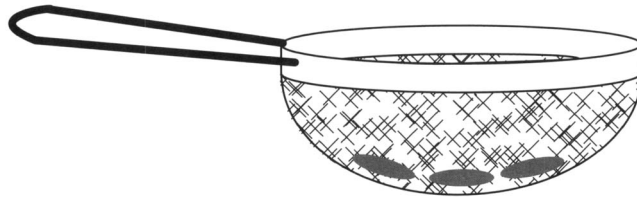
- SKILLS**
- Working cooperatively.
 - Using equipment with care.
 - Observing with care and accuracy.
 - Recording results accurately.
 - Understanding a fair test.

Key ideas and activities

These activities begin with those for young children and progress through to the end of the primary stage;

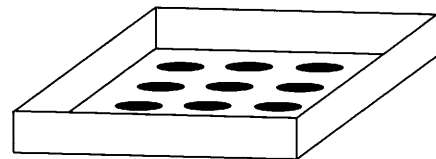
Particles of different sizes can be separated by sieving

- (a) A variety of different solid/solid mixtures can be given to children together with sieves and colanders of different sizes so that they can separate out the different sized pieces. It is better to try and make these fit into everyday situations rather than make them too contrived. Who needs to separate sand from peas? A few suggestions are: sieving lumps from flour, rice from salt, coffee from coffee beans, stones from soil, stones from sand, different sized seeds, sugar from sugar lumps, buttons in a button box, buttons and poppers, beads. In the last activities, the children could make their own sieve if you can't find one that is big enough. You can cut larger holes on the mesh on a cheap, large, plastic sieve or cut holes out of the bottom of a card box. The children may have ideas of their own.



Cut bigger holes in a plastic sieve.

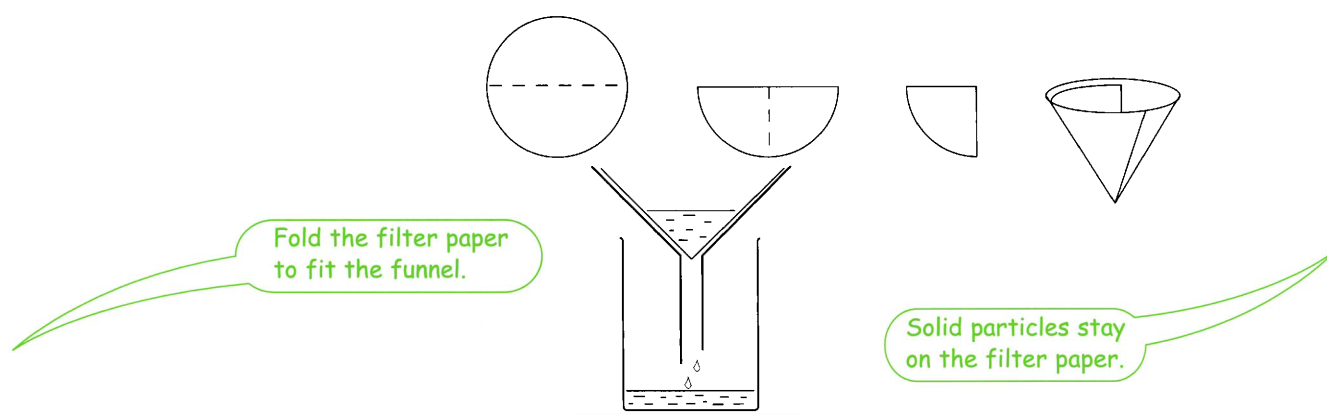
Make your own sieve from a box.



- (b) Use graded sieves to separate soil samples, so that the composition of the soil can be closely observed. (Refer also to section on Rocks and Soils.)

Insoluble solids can be separated from liquids by filtering (and straining)

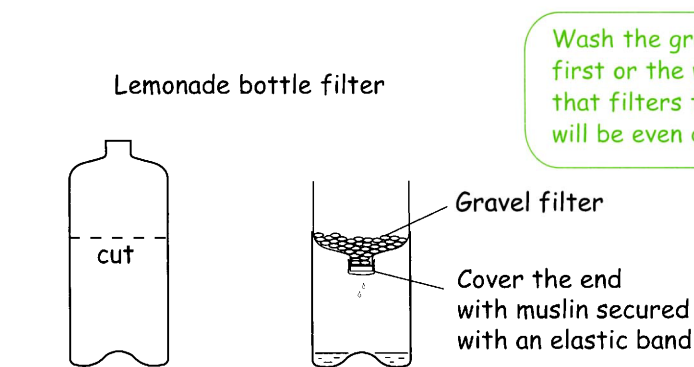
- (a) Discuss how to and try to separate a variety of liquid/solid mixtures that are within the children's everyday experience, such as water with different vegetables, washing rice, straining tea, looking at a cafetière. Are you retrieving the solid or the liquid?
- (b) Look at teabags, put them in hot water and get the children to observe and explain what is happening. Why is the resultant liquid brown? This activity which is familiar to the children, can lead into the idea of 'filters'.
- (c) Demonstrate making coffee with a coffee filter, what happens if you use a fine strainer instead? Why are different grades of coffee recommended for different types of coffee machines?
- (d) Recover the sand and water from a sand and water mixture. Try a fine sieve first, the water is still very cloudy even though much of the sand has been retrieved. If the children then continue to filter the cloudy water using filter paper in a funnel, the water will get clearer.



Safety!

- Care when handling glassware.
- Care with candles; stand in a sand-filled tray.
- Care with hot liquids.
- Care when using soils and sand.
- Plastic gloves should be used and hands washed afterwards.
- The soil should be checked for sharp materials and animal faeces.

- (e) Discuss filters with the children and talk about uses for them other than domestic uses, such as cleaning wastewater. As it is not always practical to use filter paper (it easily tears when wet as they may discover), discuss the use of other filters. A good system for trying out other filters other than with a filter funnel is to use a plastic lemonade bottle. Cut off the top at about a third of the way down. Put muslin or nylon secured with an elastic band over the narrow, neck end and invert this into the base of the bottle. Now you can put any filter material into the top. It is easy and cheap to make.



- (f) **Investigate** 'Which is the best filter?' You may get the children to suggest different filters to try or offer them a range, such as washed gravel, washed sand, cotton wool, steel wool, muslin or nylon tights. Get them to predict, with reasons, which they think will be the best. Some children might repeat the experiment trying two filters, either one after the other or putting two filters or more together in layers, one on top of another, to get the best result.
- (g) **Decanting** Leave a jar of muddy water to stand for the day, then pour off the water as far as you can without disturbing the **sediment**. The separated water is usually very clear.

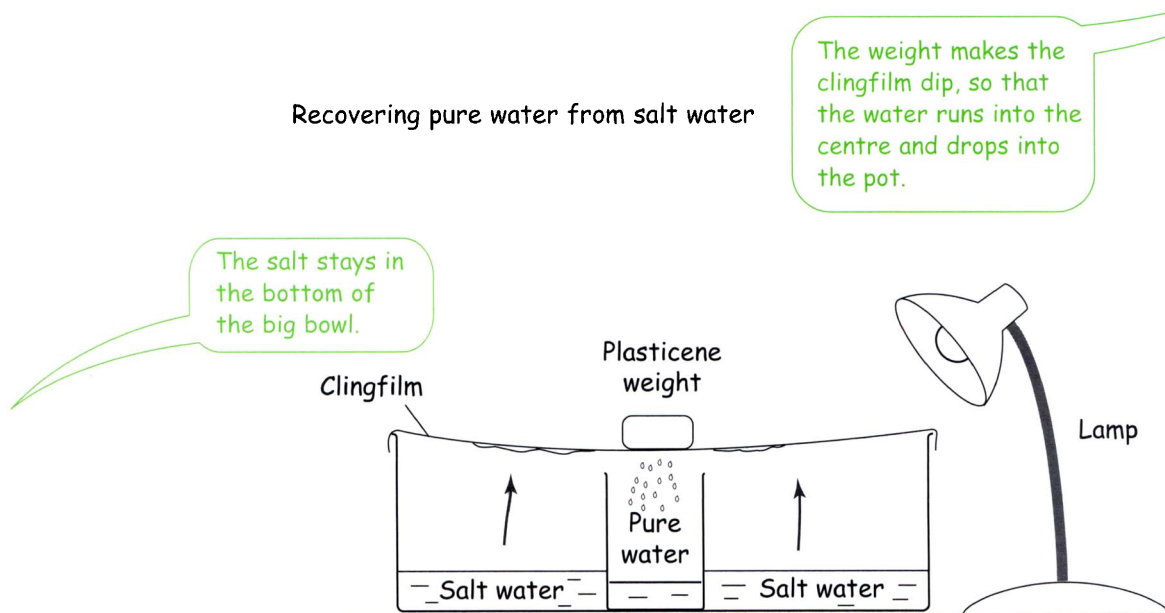
Recovering dissolved solids by evaporation

- (a) The children need to have experience of evaporating and may have experience of solids being left behind when the liquid evaporates from the evaporating activity (Refer also to Water cycle-evaporation section.) This can be discussed with them. Let the children make their own solutions and leave them out in shallow dishes for them to observe the solid that is left behind eg salt water, sugar solution, ink, instant coffee.
- (b) The above activity (a) can be repeated but speeded up by gently heating the solution over a candle. Get them to predict the colour of the ink and coffee vapour before they start.
- (c) Discuss where salt comes from and get them to plan an **investigation** into recovering clean salt from either dirty, salty water or for older, more able children dirty, gritty salt. Both investigations require **filtration and evaporation**, but for the second activity the children need to realise that water must be added first to make a solution

Using knowledge of solids, liquids and gases to decide how mixtures might be separated

Recovering the liquid from a solution: Investigate how to obtain pure water from salt water, a problem that often has to be solved in countries where there is a water shortage. This is for older or more able children to **investigate**, or it can be a class demonstration. The basic principle involved is evaporating the water from the salt and water mixture and then condensing the vapour to obtain the clean liquid, leaving the salt behind. Children need to be familiar with the concept of condensation, discuss and remind them. The problems of obtaining fresh water in countries where there is little available can also be discussed. (The investigation may be made more complex by having sandy, salty water, which needs to be filtered first to remove the sand.) This is how it may be demonstrated.

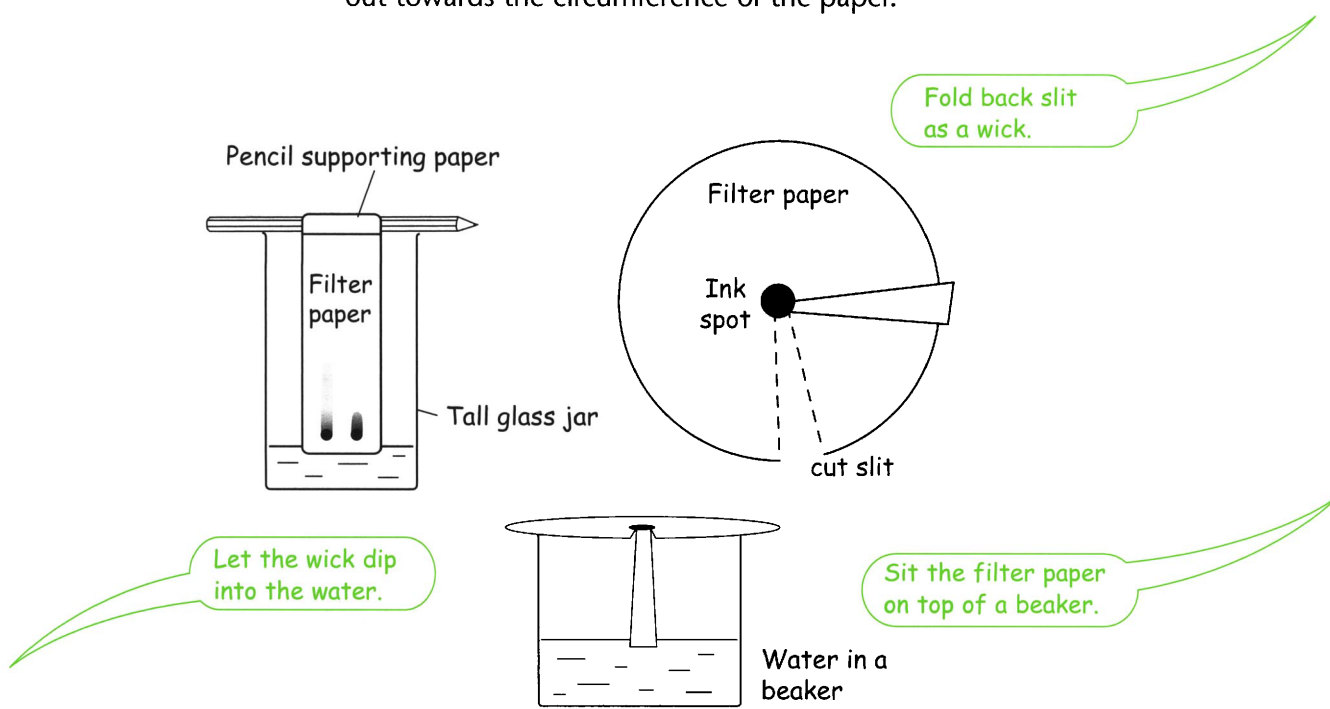
Recovering pure water from salt water



You could use the concept cartoon *Sugar in tea* here.

Chromatography Test a variety of water soluble inks or fibre tip pens before giving them to the children to make sure that the colours will separate out. There are two basic methods:

- Cut a strip of filter paper, put a dot of the colour or colours to be tested about 3 cm up from the bottom and stand in a tall jar containing water that is approximately 2 cm in depth. The water seeps up the paper, washes through the colour and separates out the colours.
- Put a dot of colour in the centre of a circular piece of filter paper. Cut 2 slits in the circle from the edge to the spot and bend the slit up, making a 'wick'. Allow the 'wick' to dip into water so that the water seeps up to the ink spot. The colours will then separate out towards the circumference of the paper.



Separating magnetic materials

The children may need to be reminded about earlier activities with magnetic and non-magnetic materials.

- Separating metal (magnetic) from other material**
Separate the metal poppers or buttons from the plastic ones in the button box. A very simple **investigation** for younger children.
- Separating a mixture of metals** Using a magnet, separate the brass from the steel screws that have been mixed in a box. Discuss the separation of metals for recycling for example at waste disposal facilities.



star*
Poetry

by Michael Rosen

Soapy Spuds Potatoes can end up in the sink when you strain them!

Button Box Anything with holes or gaps can be a sieve, even fingers.

Summer Sand When you wash holiday clothes, sometimes the sand stays in the machine. [See page 71.](#)

Salty Wave When you swim in the sea, sometimes the salt stays on your skin. [See page 111.](#)

Soapy Spuds

Dad was straining the potatoes
when he said to me:
Ssssh!
Don't tell anyone:
some of the spuds have fallen out of the colander
and into the sink.
I've put the ones that fell out
back in with the others.
No one'll notice.
Sssh!
Don't tell anyone.

So I didn't tell anyone.
And he was right.
No one noticed.
No one at all.
He got away with it.
Brilliant.

One problem:
my potatoes
tasted of washing up.

Thanks Dad.

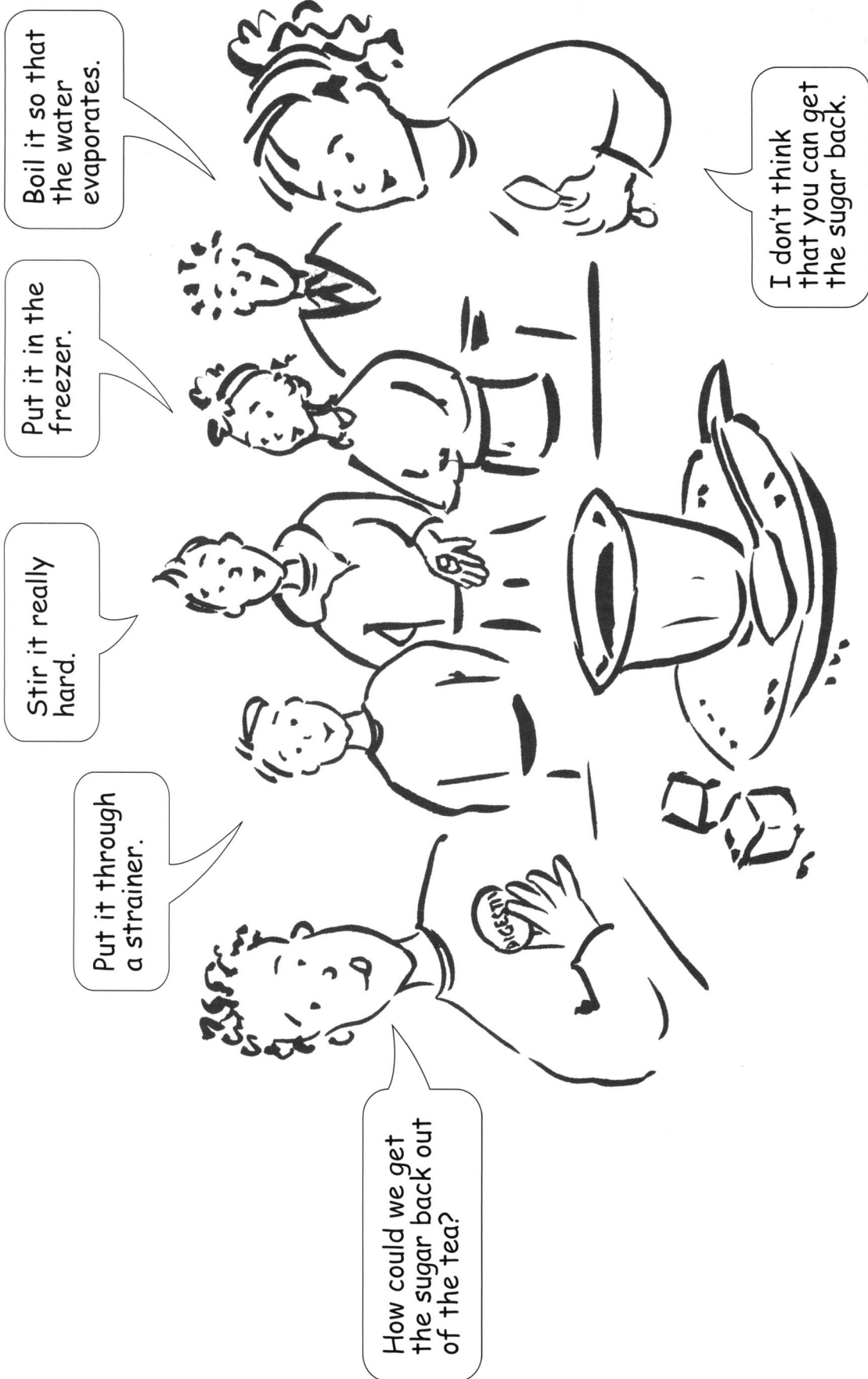
Button Box

I go fishing
in the button box
digging my hand
deep down inside,
making a cup
with my fingers,
pulling my hand
slowly upwards,
letting the small boring buttons
slip through the gaps
between my fingers...

...so I can catch
the gold buckle
off grandma's shoe,
the fat domed button
that comes dressed
in purple cloth,
the American Army badge,
and the glass eye-ball
that stares at me
from the palm of my hand.

SUGAR IN TEA

RS•C



CONCEPT CARTOONS

Sugar in tea This concept cartoon invites the children to reverse the familiar process of dissolving. It also challenges the children's ideas about what happens to the sugar in the tea – does it disappear completely as it dissolves or can it be recovered from the tea? The children can investigate the possibilities shown in the concept cartoon as well as other possibilities that they might suggest. Salt is a useful alternative, since it can be separated more easily from water than the sugar. Other means of separating materials would be useful ways to follow up this investigation.