Energy and change

A project funded by the Nuffield Foundation

Theme A

Mixing and 'unmixing'

Theme A - Mixing and 'unmixing'

What is this theme about?

Matter tends to spread out. For example, salt dissolves in water and pollution spreads out in the air. In these changes, substances are mixing together - they are changes which 'just happen' by themselves. In contrast, it is rather more difficult to 'unmix' or separate substances - matter tends not to 'bunch together'. (This is not to say that matter *never* 'bunches together'. But it can only happen if something else is changing - for example, a hot solution crystallises as it *cools*.)

This theme is concerned with changes in which substances become mixed or separated. The essential point is that mixing tends to happen more easily than 'unmixing'. There are many familiar examples from everyday life of this. Pupils are encouraged to pay attention in these kinds of changes to what is happening to the substances involves - are they 'spreading out' or 'bunching together'? Later themes will look at a wider range of changes - for example, changes of state in Theme C, and changes in which substances change into other substances (i.e. chemical reactions) in Theme F.

The activities

A1 Backwards and forwards in the kitchen

A2 Pictures of mixing

A3 Dissolving - speeding it up

A4 Mixing and 'unmixing'

A5 Mixing and 'unmixing' - 'downhill' and 'uphill'

A6 Pictures of separating

A7 'Spreading out' and 'bunching together'

Activity A1 - Backwards and forwards in the kitchen

The activity is about dissolving. Changes in which things are mixed (e.g. dissolving) happen more easily than changes in which they are 'unmixed'.

Sheet 1 contains information about the task, and may be used as an OHP. The idea of changes which happen more easily in one direction is introduced by thinking about a video of such changes being shown 'forwards' or 'backwards'.

Sheet 2 is for pupils. Each change on this sheet appears twice - once forwards and once backwards. The reason for this is to encourage pupils to think about each change in both directions and to familiarise them with the 'before' and 'after' conventions used in these materials.

Answers:
'Going forwards' - B, D, E, F, I, J
'Going backwards' - A, C, G, H, K, L

In writing up their reasons, pupils should be encouraged to use the terms 'mixing' and 'unmixing'.

Activity A2 - Pictures of mixing

The activity is about matching changes to abstract pictures involving mixing. It also encourages pupils to think about mixing as a process in which substances 'spread out'.

Sheet 1 introduces the conventions of the abstract pictures with matched examples, and may be used as an OHP. The conventions are:

When discussing these pictures with the class, pupils should be encouraged to use the list of words shown. For example:

- Coffee powder is a *solid*, hot water is a *liquid*. The coffee is *soluble* in water. They *mix* to make a *liquid*. The coffee *dissolves* in the water. The coffee *spreads out* into the water.

- Milk and black coffee are both *liquids*. When they are *mixed*, the milk *spreads out* into the coffee.

- Salt and pepper are both *solids*. When they are stirred together, they *mix*. They *spread out* into each other.

- The dirt is *soluble* in soapy water, but the plates are *insoluble*. The dirt *spreads out* into the soapy water.

Sheet 2 is for pupils. They need to match the changes to the pictures. Note that there are no matches for pictures 2, 5 and 8 - these all show impossible changes in which something literally 'disappears' with the solvent remaining unchanged. Some pupils may have difficulties with these. For weaker pupils, the activity could be made less demanding by omitting pictures 6, 7 and 8, and examples C, G and H.

Answers:

1 E	2	3 F
4 A D	5	6 B
7 C H	8	9 G

In writing about the changes, pupils should be encouraged to pay attention to whether the substances are 'spreading out', and what they are 'spreading out' into.

Activity A3 - Dissolving - speeding it up

The activity is about the factors which affect the rate of dissolving. Again, it emphasises dissolving as a process of 'spreading out'.

It would be appropriate to do this activity after the pupils have done some related experimental work. There is only one sheet, which may be used as both an OHP and a worksheet by the pupils.

Answers:

1 C	2 F
3 B D	4 A E

In writing about the changes, pupils should again be encouraged to use the term 'spreading out'.

(N.B. A subtle point, not intended to be taken up at this stage, is the distinction between *how quickly* a substance dissolves and *how much* dissolves. Making a solid into a powder (1) or stirring (3) increase the *rate* but not the amount that dissolves. Using more liquid (2) or making it hotter increase both the *rate* and the *amount*.).

Activity A4 - Mixing and 'unmixing'

This is a class discussion which introduces the idea that mixing is a process which happens more easily than 'unmixing'.

This is based on an OHP which may be used to lead into the remaining pupil activities in this theme. In these they will match situations involving mixing and 'unmixing' to abstract pictures, and will describe changes using the phrases:

'downhill' and 'uphill'
mixing and 'unmixing' or separating
'spreading out' and 'bunching together'

The OHP could be usefully introduced after pupils have looked at mixing and before they go on to look at ways of 'unmixing' or separating, e.g. evaporation of solution, distillation, crystallising, etc.. The main point is that mixing is a 'downhill' change and that 'unmixing' is an 'uphill' change. When they are looking at separating techniques, they should be encouraged to use the terms 'spreading out' and 'bunching together'. They need practice at using these terms.

The OHP can be introduced in a 'fun' way by setting up the first example as an 'unfair competition' - the teacher having to mix two beakers with white and red balls and a pupil having to 'unmix' the beaker with the balls mixed together. Who will do it first? Why is it unfair? How could it be made fairer? Who would win a second round of the competition (with teacher unmixing and pupil mixing)?

Activity A5 - Mixing and 'unmixing' - 'downhill' and 'uphill'

This is a brief activity intended to make the point that mixing 'just happens' but 'unmixing' does not 'just happen'.

It would be appropriate to refer back to the OHP from activity 4, before pupils attempt the worksheet. Note that the changes D, E and F are simply the reverse of changes A, B and C, so that the pattern of answers is simple to see.

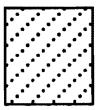
Answers:
A, B and C are all 'mixing' changes which 'just happen'.
D, E and F are all 'unmixing' changes which 'do not just happen'.

Pupils are asked to think about examples of their own.

Activity A6 - Pictures of separating

The activity is about matching changes to abstract pictures involving separating. It also encourages pupils to think about what similar processes have in common.

It would be appropriate to do this activity after the pupils have done practical work on separation - decanting, filtering, dissolving, evaporating, distilling, etc.. There is only one sheet, which may be used as both an OHP and a worksheet by the pupils. The conventions are the same as those in activity 2, with one addition which needs to be introduced to pupils - a vapour is represented as:



This activity is more demanding than the similar activity for mixing (A2). It could be simplified by omitting pictures 3 and 6, and examples B, F, H and L.

Answers:

1 C J	2 A D	3 B F
4 E I	5 G K	6 H L

After matching, pupils are asked to write about similarities between the pairs, so discussion of the correct answers would be appropriate before they started this.

Activity A7 - 'Spreading out' and 'bunching together'

The aim of this activity is to encourage pupils to use appropriate language for describing processes of mixing and separating.

Sheet 1 is an OHP which illustrates what pupils should do on the worksheets - the correct answers are already circled. Sheets 2 and 3 are the pupils' worksheets.

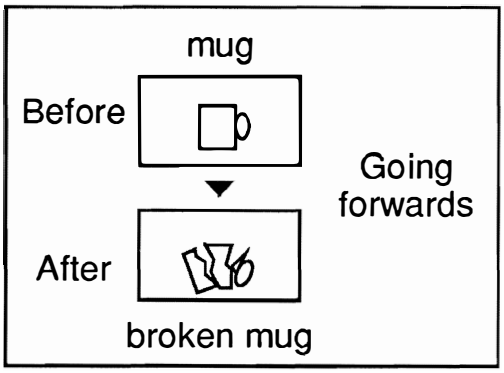
There are two aspects to this activity - helping pupils to identify what is happening in different changes, but more importantly encouraging them to use these ideas in their own descriptions. The 'circling words' activity takes up most of the room on the worksheet; however, the last part, in which pupils describe changes in their own words is the essence of the activity.

Backwards and forwards in the kitchen

Some changes happen more easily than others.

Breaking a mug

These pictures show a mug breaking.



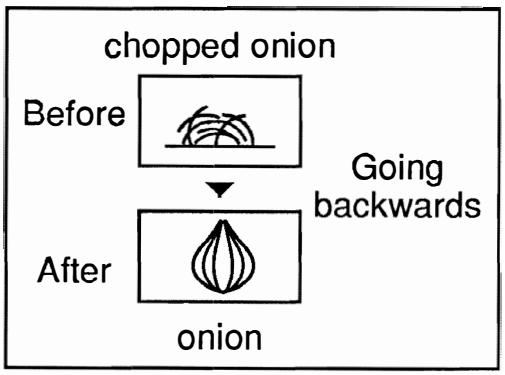
If you saw a video of this happening, you would guess that it was being played *forwards* not *backwards.*

It is easier to break a mug than to get the mug back.

This change happens more easily forwards than backwards.

'Unchopping' an onion

These pictures show an onion being 'unchopped' to make a whole onion.



If you saw a video of this happening, you would guess that it was being played *backwards* not *forwards.*

It is easier to chop up an onion than to get the onion back.

This change happens more easily backwards than forwards.

Backwards and forwards in the kitchen

Sheet 2

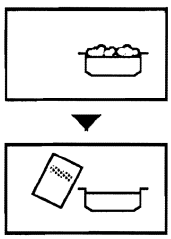
1 Cut out the pictures below.

2 Sort them into two groups 'Going forwards' and 'Going backwards'.

3 Stick the pictures in the group 'Going forwards' in your books.

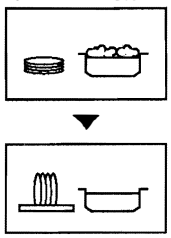
4 Why do you think these changes go forwards more easily than backwards?

A soapy water



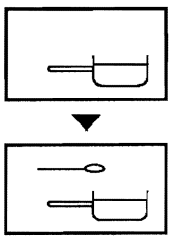
soap powder and water

B dirty plates and clean water



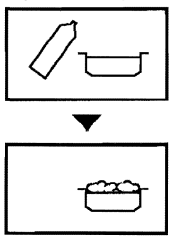
clean plates and dirty water

C salty water



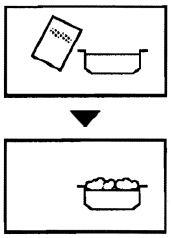
salt and water

D washing-up liquid and water



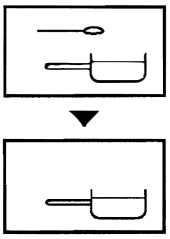
soapy water

E soap powder and water



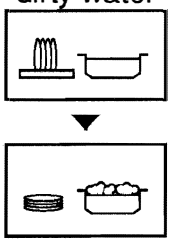
soapy water

F salt and water



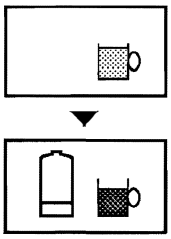
salty water

G clean plates and dirty water



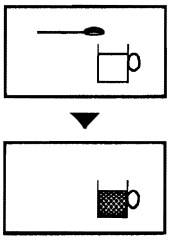
dirty plates and clean water

H white coffee



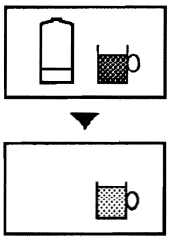
milk and black coffee

I coffee powder and hot water



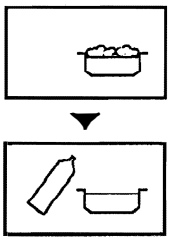
hot coffee

J milk and black coffee



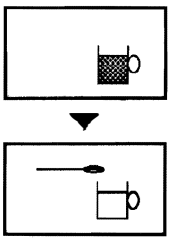
white coffee

K soapy water



washing-up liquid and water

L hot coffee



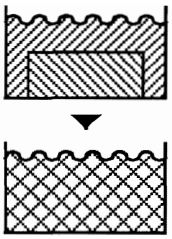
coffee powder and hot water

Pictures of mixing

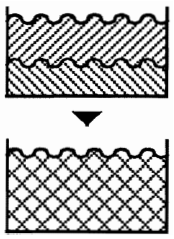
Here are some pictures showing different kinds of mixing.

Some useful words for talking about these changes are:

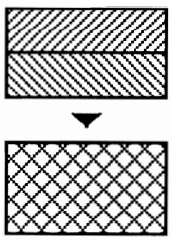
mixing	spreading out	solid	liquid	dissolving
solvent	solute	solution	soluble	insoluble



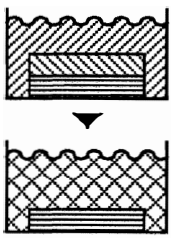
adding coffee powder to hot water to make coffee



adding milk to black coffee to make white coffee



stirring salt and pepper together



using soapy water to clean dirty plates

Pictures of mixing

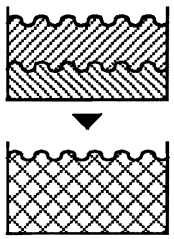
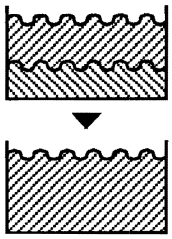
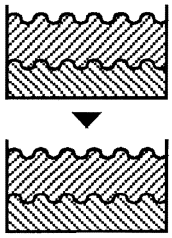
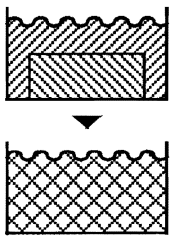
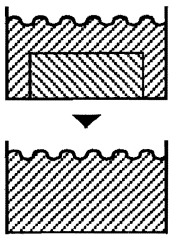
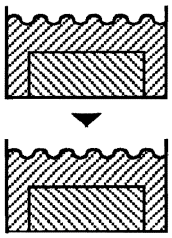
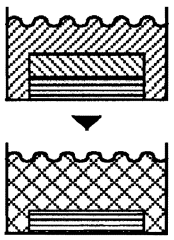
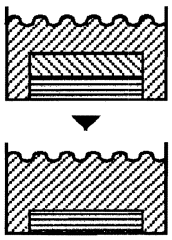
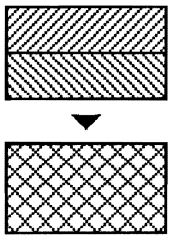
Sheet 2

1 Cut out the boxes at the bottom showing different changes.

2 Match them to pictures below.

3 Write about each change. Here are some words which might help you:

mixing	spreading out	solid	liquid	dissolving
solvent	solute	solution	soluble	insoluble

1 	2 	3 
4 	5 	6 
7 	8 	9 

A dissolving sugar in a cup of tea	E adding water to orange squash
B adding sand to water	F adding oil to water
C washing a dirty T-shirt	G stirring flour and sugar together
D adding instant coffee to hot water	H making a cup of tea using a tea bag

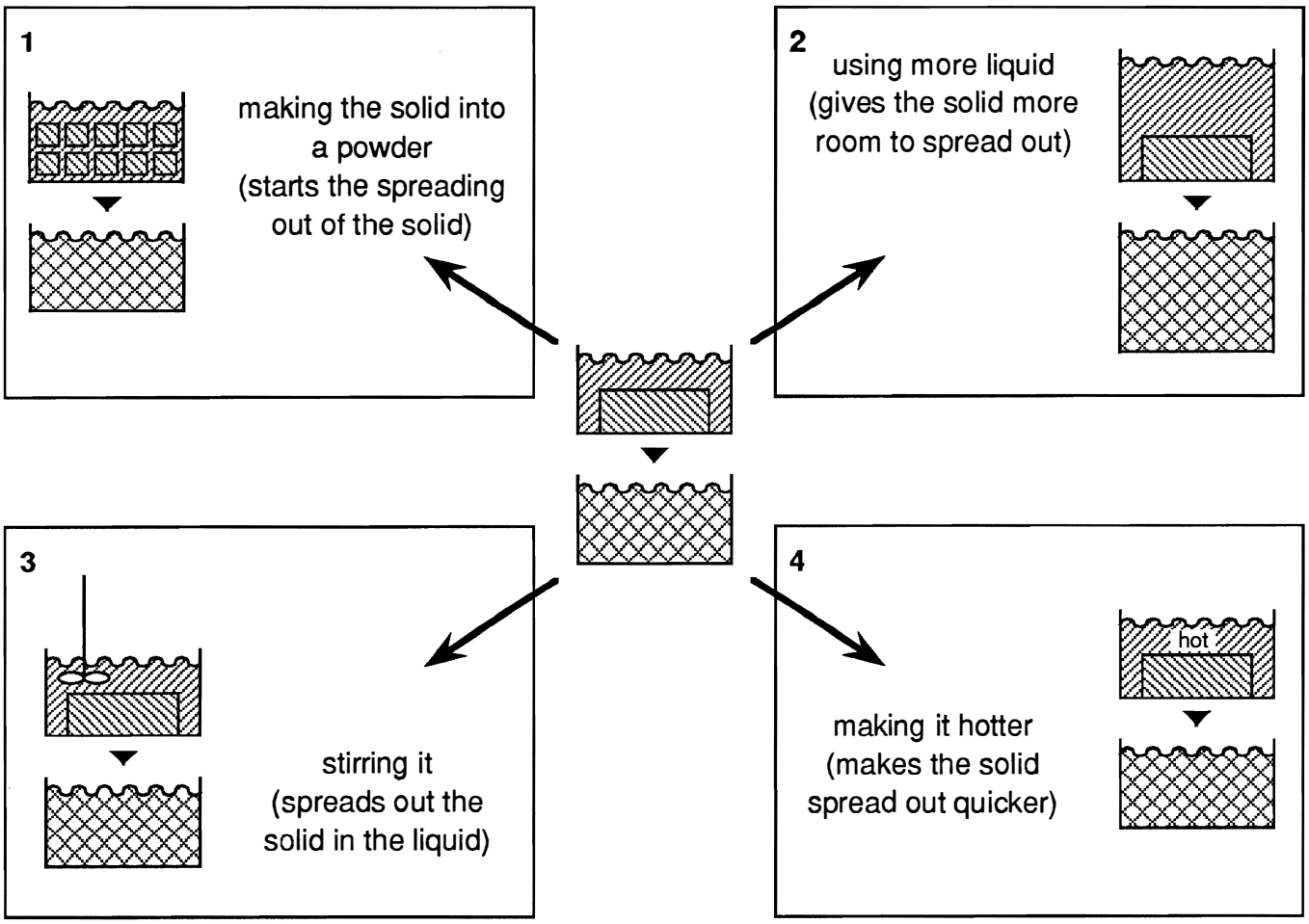
Dissolving - speeding it up

Sheet 1

Here are four ways of making things dissolve faster (for example, dissolving sugar in water).

Example: a sugar cube dissolves quicker if you crush it

Example: sugar dissolves quicker in a lot of water than in a little water



Example: sugar dissolves quicker if you stir it

Example: sugar dissolves quicker in hot water than in cold water

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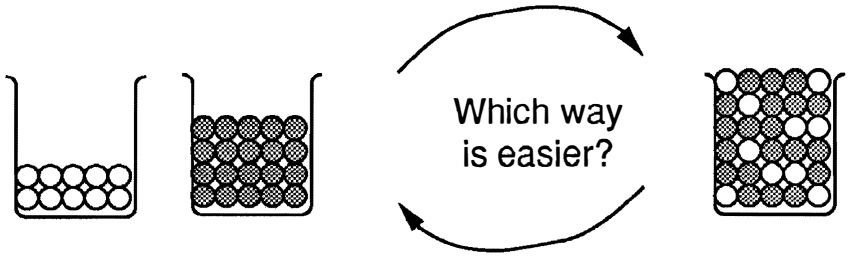
Match these changes to the ways of speeding up dissolving. Write about how each one happens.

A Using hot water to wash clothes is normally better than using cold water.	D Clothes are cleaned quicker in a washing machine than by soaking them.
B You can make a strong cup of tea quicker by prodding the tea bag.	E We make tea using hot water not cold.
C Soap powder dissolves quicker than a bar of soap.	F It is better to use a lot of water to clean a paint brush.

Mixing and 'unmixing'



This way is easier →

It is a 'downhill' change.

The balls are mixing together.

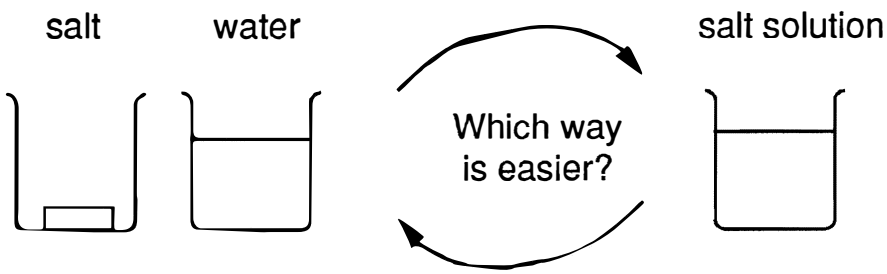
The white balls are 'spreading out' into the red balls.

← This way is harder.

It is an 'uphill' change.

The balls are 'unmixing'. The balls are being separated.

The white balls are 'bunching together'.



This way is easier →

It is a 'downhill' change.

The salt and water are mixing together.

The salt is 'spreading out' into the water.

← This way is harder.

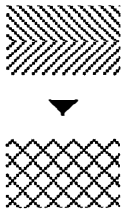
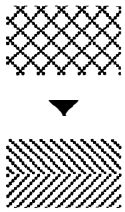
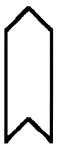
It is an 'uphill' change.

The salt and water are 'unmixing'. They are being separated.

The salt is 'bunching together'.

Mixing and 'unmixing' - 'downhill' and 'uphill'

Sheet 1

Here are some changes. Tick the boxes you think describe what happens in each change.	Is something mixing? Or is something 'unmixing' or separating?		Is the change something that 'just happens' (like going downhill)? Or is it something that 'does not just happen' (like going uphill)?	
	mixing 	'unmixing' or separating 	'just happens' 	'does not just happen' 
A coffee powder in a cup of hot water changing into hot coffee	❑	❑	❑	❑
B washing-up liquid in a bowl of water changing into soapy water	❑	❑	❑	❑
C sugar in a cup of tea changing into sweet tea	❑	❑	❑	❑
D a cup of coffee changing into coffee powder and water	❑	❑	❑	❑
E a bowl of soapy water changing into washing-up liquid and water	❑	❑	❑	❑
F a cup of sweet tea changing into sugar and tea	❑	❑	❑	❑

1 Which are the changes which 'just happen' - mixing or 'unmixing'?

2 Which are the changes which 'do not just happen' - mixing or 'unmixing'?

3 Can you think of any other examples of you own?

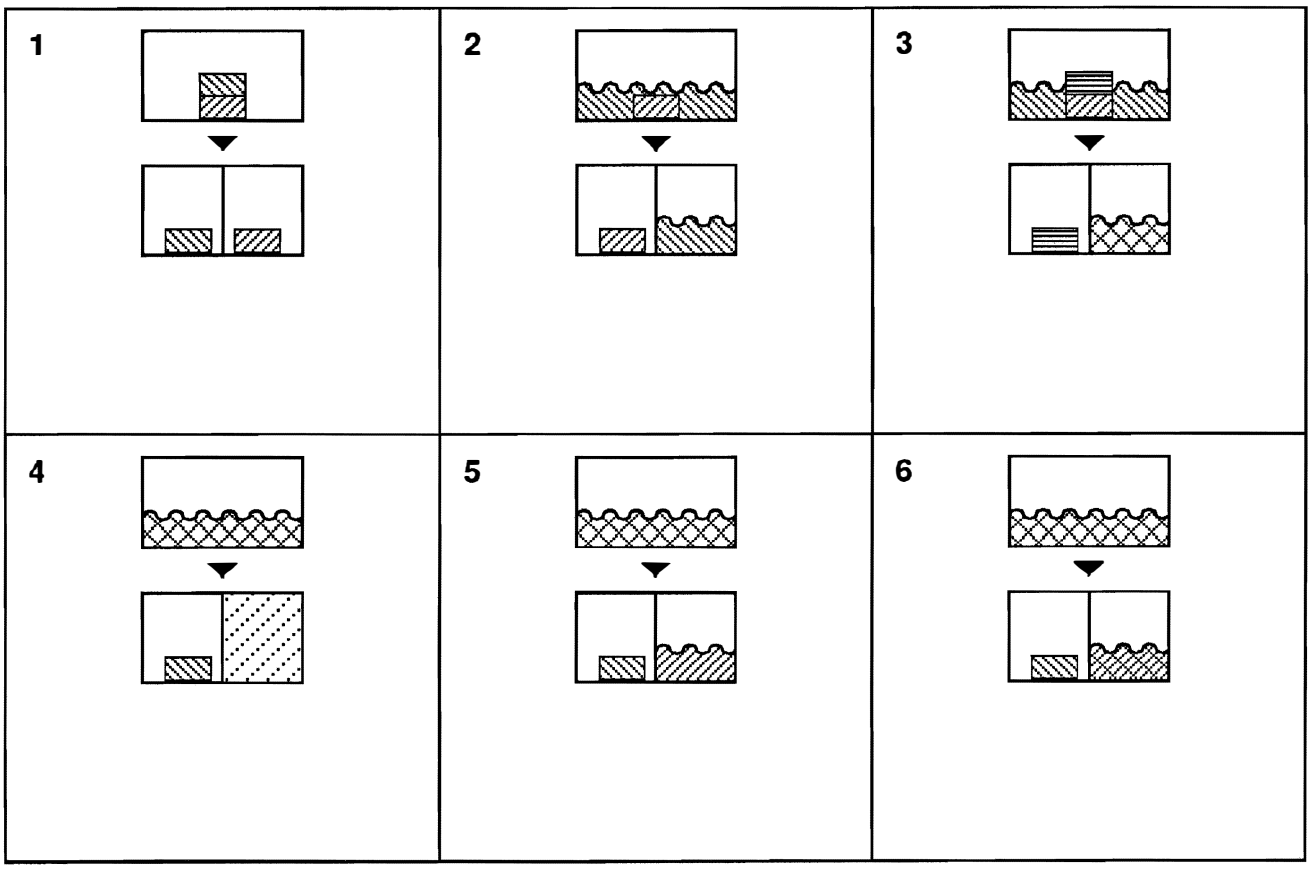
Pictures of separating

Sheet 1

1 Cut out the boxes at the bottom showing different changes.

2 Match them to pictures below. There are *two* changes for each picture.

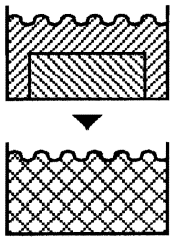
3 Write about each pair of changes - what is similar about them?



A separating peas from boiling water after cooking them	G getting fresh water by distilling sea water
B washing dirty clothes in water to dissolve the dirt, leaving the clothes clean	H copper sulphate crystals forming when a hot solution is cooled
C separating a mixture of rice grains and sugar by hand	I evaporating hard water leaving a solid behind
D filtering water through gravel beds in a waterworks to remove solids	J using a magnet in a scrap yard to separate steel from other metals
E in hot countries, making salt by leaving sea water to be heated by the sun	K distilling copper sulphate solution to get pure water and copper sulphate
F adding a mixture of salt and sand to water	L sugar crystals forming in a pot of honey when it is left for a long time

'Spreading out' and 'bunching together'

Think about some salt dissolving in water



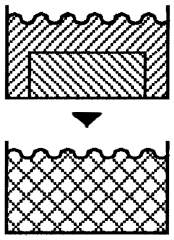
Here are some ways of talking about what is happening.

Nothing (Salt) Water	is mixing	with salt. (with water.)	(Nothing) Salt Water	is separating	from salt. from water.
Nothing (Salt) Water	is 'spreading out'	into salt. (into water.)			
(Nothing) Salt Water	is 'bunching together'.				
The change	(just happens) does not just happen.		It is	(a 'downhill') an 'uphill'	change.
The change happens more easily	(forwards.) backwards.				

'Spreading out' and 'bunching together'

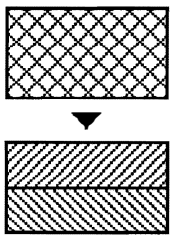
Put circles around the words, so that the sentences make sense.

A sugar dissolving in a cup of tea



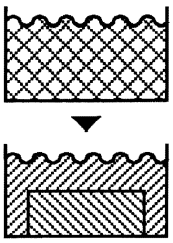
Nothing Sugar Tea	is mixing	with sugar. with tea.	Nothing Sugar Tea	is separating	from sugar. from tea.
Nothing Sugar Tea	is 'spreading out'	into sugar. into tea.			
Nothing Sugar Tea	is 'bunching together'.				
The change	just happens. does not just happen.		It is	a 'downhill' an 'uphill'	change.
The change happens more easily	forwards. backwards.				

B getting sugar from a mixture of sugar and sand



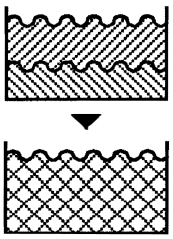
Nothing Sugar Sand	is mixing	with sugar. with sand.	Nothing Sugar Sand	is separating	from sugar. from sand.
Nothing Sugar Sand	is 'spreading out'	into sugar. into sand.			
Nothing Sugar Sand	is 'bunching together'.				
The change	just happens. does not just happen.		It is	a 'downhill' an 'uphill'	change.
The change happens more easily	forwards. backwards.				

C getting salt from salt solution



Nothing / Salt / Water	is mixing	with salt. / with water.	Nothing / Salt / Water	is separating	from salt. / from water.
Nothing / Salt / Water	is 'spreading out'	into salt. / into water.			
Nothing / Salt / Water	is 'bunching together'.				
The change	just happens. / does not just happen.		It is	a 'downhill' / an 'uphill'	change.
The change happens more easily	forwards. / backwards.				

D making a drink by adding water to orange squash



Nothing / Squash / Water	is mixing	with squash. / with water.	Nothing / Squash / Water	is separating	from squash. / from water.
Nothing / Squash / Water	is 'spreading out'	into squash. / into water.			
Nothing / Squash / Water	is 'bunching together'.				
The change	just happens. / does not just happen.		It is	a 'downhill' / an 'uphill'	change.
The change happens more easily	forwards. / backwards.				

Now write about what is happening in these changes in your own words.

a) adding a mixture of salt and sand to water
b) in a factory, removing water from milk to make milk powder
c) copper sulphate crystals forming as a hot solution cools down
d) hard water evaporating leaving behind a solid