MIXING AND DISSOLVING MATERIALS

Science background for teachers

VOCABULARY

Mixture, solid, liquid, gas, solution, suspension, dissolve, factors, saturated, soluble, insoluble, permanent, reversible, separate, sieve, change, solvent

Mixing materials together forms a **mixture** where two or more substances are physically but not chemically combined and can be separated again by physical methods such as sieving, filtering, evaporating etc. This means that the change can be reversed. A new material is not formed as it is in a chemical reaction. Mixtures can be made up of;

- solid in solid (muesli)
- gas in solid (pumice stone)
- solid in gas (smoke)
- gas in gas (air – mostly made up of nitrogen and oxygen)
- liquid in gas (clouds, mist, aerosol)
- gas in liquid (oxygen in water)
- liquid in liquid (emulsion – milk)
- insoluble solid in liquid (suspension – muddy water)
- soluble solid in liquid (solution – salt water).

Mixing materials together may form a new substance but not a mixture, as with Plaster of Paris and water. A **chemical** reaction has taken place in which case a completely **new** substance has been formed and the original substances cannot easily be recovered. The word 'mixture' is not always used correctly in its scientific sense. A cake mixture for example is so until water is added and it is baked. A chemical change has then taken place and it is no longer a 'mixture' but a cake! A safe way of referring to such situations might be to call them a 'mix'. Activities involving baking mixtures have been left out of this section and are included in the section 'Heating and cooling materials'.

DISSOLVING

When the mixture is **a solid in a liquid** it will either produce a **solution** or a **suspension.** A solution is clear and will never settle out, a suspension is cloudy and will eventually settle out. If the solid **(solute)** dissolves in the liquid **(solvent),** a solution is formed. Although at primary level the solvent mostly used is water, older children need to know that there are others. These will dissolve other solids that may not dissolve in water eg nail varnish is dissolved by propanone (acetone). Various factors that affect dissolving will be familiar to children, such as stirring, temperature, time, amount of solute, amount of solvent and can be equated with their everyday life such as stirring sugar in a cup of tea.

Sometimes a solid dissolves in a liquid to produce a solution, but not of the original substances, because the change is a chemical one, for example when Alka-Seltzer dissolves in water.

For younger children, it is sufficient to know that a change of some sort has taken place, older children can explore whether it is permanent or reversible.

SATURATED SOLUTIONS

Only a finite amount of solid will dissolve in a liquid and this is dependent on the solid and the temperature. When no more solid will dissolve the solution is saturated, but generally more will dissolve in hot than in cold liquid. So if a saturated solution of sugar is made using **hot** water, as it cools some of the sugar comes out of solution and reforms making crystals. This principle is used to grow crystals. Crystals can also, of course, be made by leaving a salt or sugar solution and allowing the water to evaporate leaving salt or sugar crystals behind.

Children often confuse **melting** and **dissolving** and this may be a point of discussion. Melting requires heat and dissolving requires a solvent. In making a jelly both are happening when it is added to hot water.

SKILLS

- Using a thermometer and stopwatch.
- Working cooperatively.
- Choosing and using apparatus carefully.
- Observing and recording accurately.
- Measuring accurately.

Key ideas and activities

Mixtures have more than one thing in them (some may be separated by sieving)

(a) Look at and discuss with the children obvious mixtures such as Dolly Mixtures, a jar of mincemeat, mixed vegetables, fruit salad, muesli. Get the children to closely observe and list the ingredients in the mixtures. Ask the question, 'Can they be separated?'

(b) It may be appropriate at this stage also to do a sieving activity to separate the various components of a mixture such as peas and rice and allowing the children to choose their own equipment or to make up their own mixture. Explain to them that to call it a 'mixture' they must be able to separate it again. This would make a good combined activity for younger children especially if some sieving is also done with soils (see Rocks and soils section). **Investigate** how to separate sand and peas, or stones and sand.

A food Design Technology activity where the children make simple 'mixtures' such as icing sugar and coconut to make 'coconut ice', design their own fruit salad or make 'chocolate crispy' cakes using melted chocolate and 'Cornflakes' or 'Rice Krispies', can also be carried out.

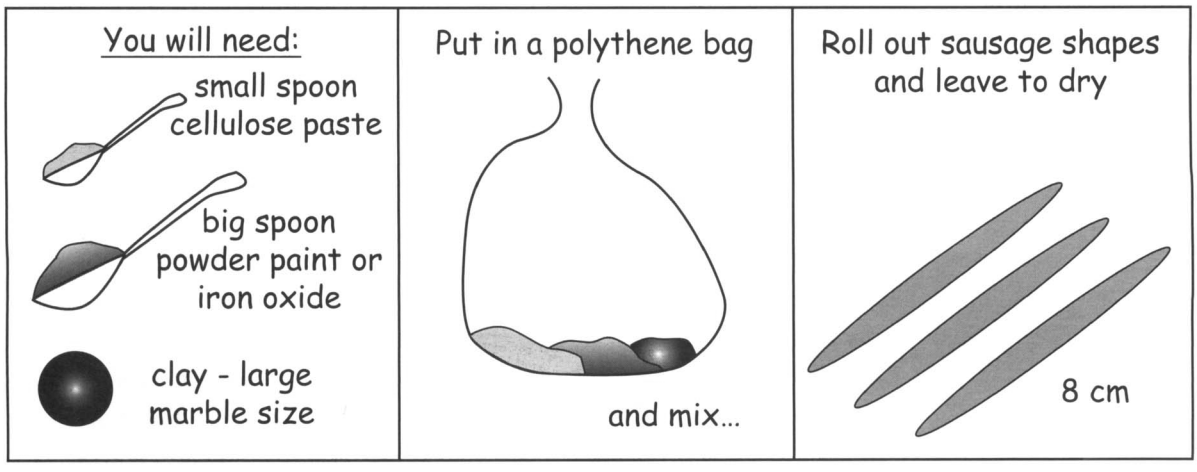
Mixing materials can cause them to change

Making pencil crayons This is a directed activity where the children need to follow a recipe for making pencil crayons. They will need:

- Large, marble-sized ball of modelling clay
- Small spoon of paste, (cellulose wallpaper paste made up with water beforehand)
- Big spoon of powder paint or iron oxide (pottery supplier or local secondary school). The paint makes 'playground pencils', the oxide makes brown thick pencil leads that write on paper.

Mix the mixture outside the bag. After rolling out the 'leads', wash your hands.

Mix the ingredients in a polythene bag by squidging it from the outside, then take it out and mix it in the hand, it resembles crumbly plasticene. Roll out the 'leads', this makes about three 8 cm lengths and leave to dry overnight on paper towels. The 'leads' can be covered in fancy paper.



Some materials dissolve in water others just mix

(a) Present the class as a whole with a wide range of materials to mix so that there can be a comparative, plenary discussion. Each group of children can have a smaller selection to work with. Include soluble and insoluble materials and get the children to record what happens each time. Suggest they stir or shake the mixtures and be patient! This would be a good lead into work on dissolving.

Good examples are;

Water with sand, sugar, salt, Alka-Seltzer, oil, coffee, lemon juice, flour;

Vinegar with oil, lemon juice, bicarbonate of soda.

At this stage the amount of each ingredient mixed is not critical but is used in the case of solids in liquids, 1 teaspoon of solid to at least 100 cm^3 of water to avoid saturation. Keep the various mixtures for the discussion.

Word processing

(b) The results of the activity could then be grouped into those materials that dissolve and those that do not, having discussed solubility first. In some of these mixings has anything new been made?

You could use the concept cartoon on ***Sandcastles*** here.

Water and:	Prediction: will it dissolve?	Did it dissolve?	Describe any other changes that occurred
Sand			
Chalk			
Sugar			
Salt			
Alka-Seltzer			
Oil			
Flour			
Coffee			

The coffee dissolved and went brown.

The Alka-Seltzer dissolved and fizzed.

There are a variety of factors which affect dissolving

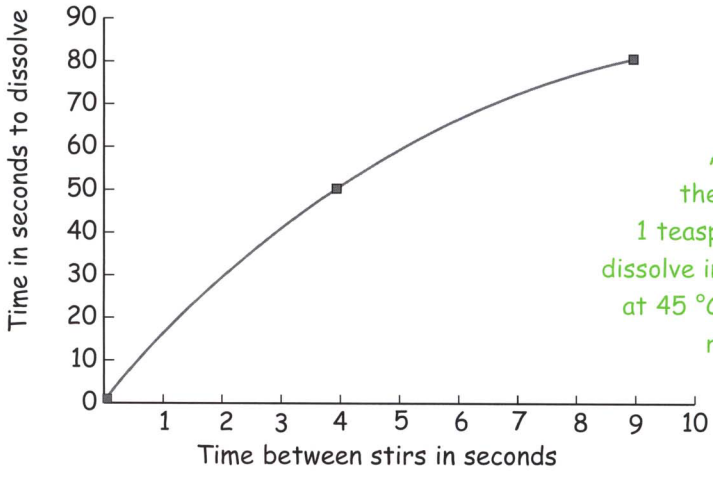
Discuss this with the children first and get them to suggest the factors that affect dissolving from their own experiences such as making a cup of tea. Get them to suggest a hypothesis, for example; 'I think that stirring affects dissolving' and then plan a way to prove it. This would make a good **investigation** or series of small investigations,

eg **Investigate** Does stirring affect dissolving? This can have particular reference to fair testing due to the large number of variables that could be investigated. In this set of quantitative investigations, care should be taken if using salt, as impurities in the salt often leave the water cloudy after it has dissolved. Consequently, it is not always clear at what point the salt dissolves.

(a) Stirring Limit the number of soluble solids eg sugar which works very well, salt (test for cloudiness first) and water even if they are planning this themselves. They can time how long dissolving takes with and without continuous stirring and stirring once every minute. Suggest 1 teaspoon of solid, even then dissolving without stirring can take a long time.

After 1 hour the sugar we didn't stir at all still hadn't dissolved!

Graphing package

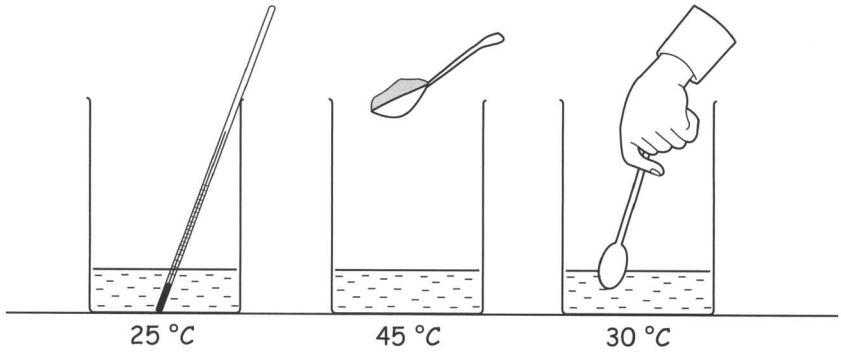


A graph to show the time taken for 1 teaspoon of sugar to dissolve in 100 cm^3 water at 45 °C with different rates of stirring

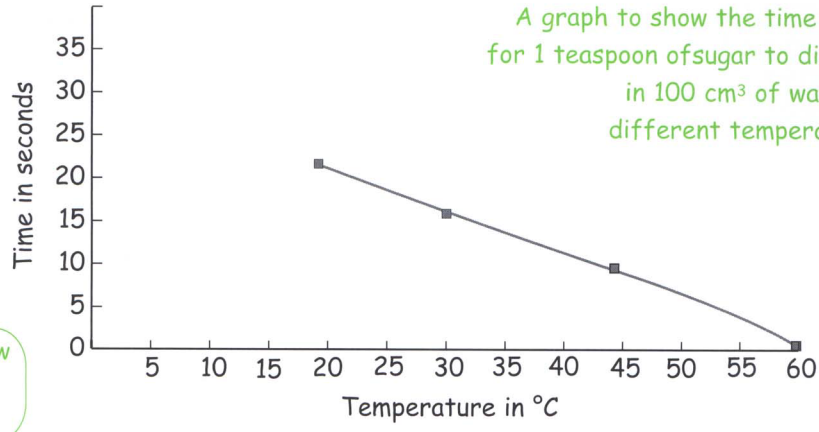
The longer it takes to dissolve, the colder the water gets!

The shorter the time between stirs, the more stirs we did.

(b) Temperature Repeat activity (a) using hot and cold water. Suggest one good stir at the beginning or continuous stirring, otherwise it can take a long time to dissolve the solid and the temperature of the water will drop.



We used 100 cm^3 of water each time and kept stirring until it all dissolved.



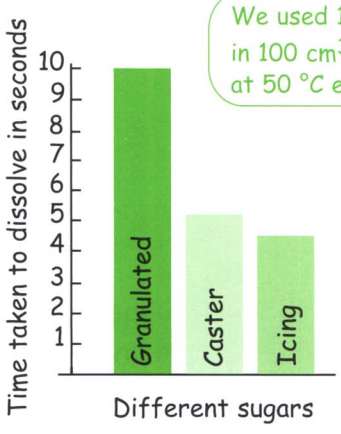
A graph to show the time taken for 1 teaspoon ofsugar to dissolve in 100 cm³ of water at different temperatures

Can you predict how long it would take at 5 °C?

(c) Size of the solid particles For convenience of time, use warm water and stir. Present the children with one solid in different forms where the grains are different sizes eg sugar – granulated, castor, icing, sugar crystals. Let the children look at the solids with a magnifying glass first and predict which will dissolve the fastest. Brown sugar contains other substances, so is not the same as white sugar and not appropriate to use.

We looked at the size of the sugar grains with a magnifying glass. The granulated sugar had the biggest grains.

We used 1 teaspoon in 100 cm³ of water at 50 °C each time.

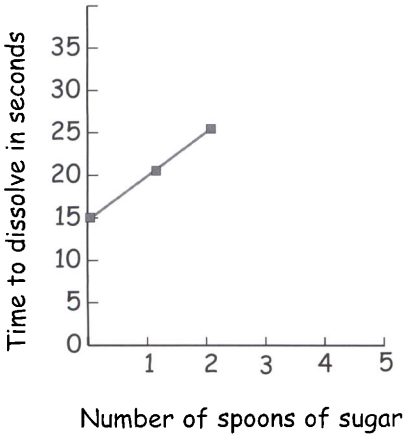


A graph to show the time taken for different sugars to dissolve

Safety!

- Care should be taken when handling glassware.
- Spirit thermometers should be used.
- Care should be taken when handling hot water.
- Remind children NOT to sample any of the ingredients – sugar is tempting.
- Some solvents are highly flammable and the room must be well ventilated.
- Polythene bags are potentially dangerous, use small ones and supervise closely.

(d) Amount of solid Again for time convenience, use warm water and stir, eg once every minute. Present the children with only a few soluble solids and ask them if the amount they put in the water affects the dissolving time.



A graph to show how the dissolving time of sugar changes with the amount of sugar mixed with 100 cm³ of water at 55 °C.

Can you predict how long 4 teaspoons would take to dissolve?

(e) **Investigate The fastest way to make a jelly!** There are many variables to be considered, temperature and quantity of the water, size of the jelly cubes, with/without stirring and temperature for setting of the jelly. Before they start the children could make a list of all the factors that they have found out that speed up dissolving. An excellent planned investigation for older children, younger or less able children will need help with coping with all the variables.

The following activities would be suitable as extension activities for more able 11 year old children, as ideas for a Science 1 investigation or ideas for a Science Club.

Note – There is a limit to the mass of solid that can dissolve in a given amount of water and this is different for different solids.

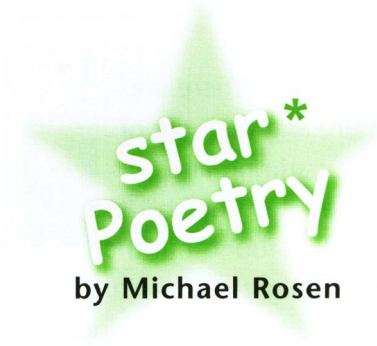
Activity (d) could lead nicely into the following activity, especially if any of the children put so much solid in the first time that it did not dissolve! A good **investigation** for able 10-11 year olds; 'is there a limit to the amount of sugar that will dissolve in 100 cm^3 of water? Is it the same for salt?'

- Keep the volume and temperature of water constant and increase the amount of solid each time until a saturated solution is reached, (ie some solid is left). Record the number of spoonfuls that will dissolve.
- Repeat the above activity with a different solid. Is the saturation point the same?
- **Growing crystals** Great fun! This can be done as a demonstration or with a small group and the whole class can watch the progress over a few days. **Tip** – The best crystals are obtained using alum (aluminium potassium sulfate – available from any chemical supplier). Sugar and salt crystals are very difficult to grow and copper sulfate should not be used in the primary sector.

Experimental method: Make a saturated solution in a jar using hot water (add as much solid as you can dissolve). Decant the solution (pour off) into a clean jar leaving behind any undissolved solid. Using a pencil, or the lid of the jar with a hole through, suspend a thread into the solution. If a lid has not been used, cover the jar opening with taped paper, to control the rate of evaporation and prevent dust dropping in on the forming crystals. Treat with care and leave undisturbed. Crystals will grow on the thread after a day or so.

Substances that do not dissolve in water can be dissolved by other solvents

It is worth demonstrating with older children how alternative solvents can be used. For example use at least one other solvent such as propanone (acetone) to dissolve nail varnish or white spirit with paint or detergent with oil.



Mayonnaise An emulsion made with eggs, vinegar and oil, which can be tricky to mix!

Making Jelly How do you make a jelly?

Summer Sand Some solids like sand do not dissolve.

Water bottles and tubes More sugar than salt will dissolve in a given volume of water.

Drizzy Fink Lemonade, carbon dioxide in water with lemon flavouring. See page 60.

Mayonnaise

A French friend of dad's
was making mayonnaise.

He poured
and mixed
and whisked
for hours
and he kept saying:
It is going to be marvellous,
it is going to be superb.

A woman walked past.

He cried out:
It is destroyed.
It is completely destroyed.

Destroyed? Said my dad.
Yes, he said,
the lady with the beard breathed on it.

Later, at home,
dad said,
I didn't see her breathe on it.
And I said,
I didn't see her beard.

Making Jelly

It's my job
to take the slab of jelly
and break it up into cubes.

It's mum's job
to pour on the boiling water
to melt the cubes.

It's my job
to stir it up
until there are no lumps left.

It's her job
to put the bowl
in the fridge to help it set.

It's my job
to eat it.

Summer Sand

The washing machine
rinses the summer holiday away
and when everything's dry
it all goes into
my chest of drawers,
with the clothes
I didn't take
That's it.

Summer over
till next year.
The beach, the surf,
the sun, the wind,
all washed away.

Weeks later
I am putting on a pair of socks
and there's the summer!
The beach, the surf,
the sun, the wind
in the sand
caught in the toe of a sock.

Water bottles and tubes

When my sister
is better
she won't have to lie in bed
between two upside-down
water bottles
with tubes going into her.

They must know my sister very well,
because one's got a little bit of salt in it
while the other's got
quite a lot sugar.

They could have done better
with that sugar one, though:
they should have made it
with chocolate milk shake.

Never mind.
When my sister
is better
she won't have to lie in bed
between two upside-down
water bottles
with tubes going into her,
and I'll make her
a big fat
mega-mega
chocolate milk-shake -
KER-PAM !!!

SANDCASTLES

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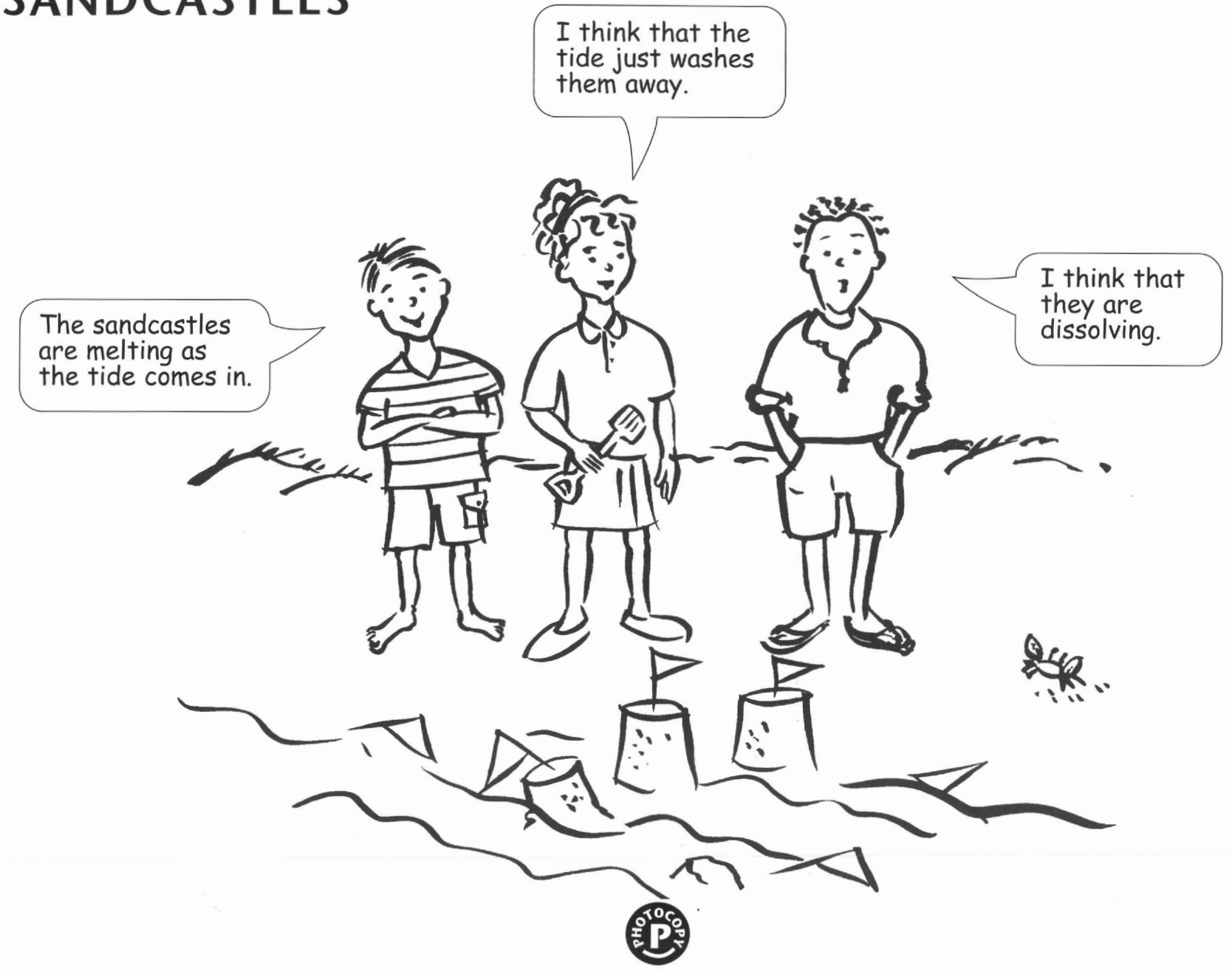

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CONCEPT CARTOONS

Sandcastles

The distinction between melting and dissolving is a common area of confusion for children. They can clarify the meaning they attach to both of these terms by investigating the situation shown in the concept cartoon. A tray full of sand can be used to model the effect of the tide on sandcastles. Observation of other changes in materials, such as melting chocolate or dissolving sugar, will be a useful complement to their investigation.

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