
Chemical change

Introduction

You can get a number of surprising effects from chemical reactions. In the early and middle school years, only simple reactions are appropriate, such as that between sodium bicarbonate (baking powder) and vinegar (or any mild acid) to produce carbon dioxide. This reaction is the basis for many intriguing activities, with effects that depend on the gas production.

Cooking provides some excellent examples of change and is a useful and popular activity in classrooms. In the ‘kitchen science’ section of this topic you can focus on techniques for observing and understanding the changes that occur in cooking, and use some novel recording strategies.

Key concepts of chemical change

The activities in this topic are designed to explore the following key concepts:

- Changes to materials can be physical (dissolving, melting, evaporating), involving changes in existing substances, and chemical (bicarb reactions, burning), involving the production of new substances.
- Substances can react together to form new substances that are quite different in their properties.
- A gas is a possible product of a chemical reaction.
- Combustion is a chemical reaction.
- A flame needs oxygen to keep burning, as the oxygen reacts with the burning substance.
- Substances can be grouped (e.g. acid/base) according to their chemical properties.

Students’ alternative conceptions of chemical change

Research into students’ ideas about this topic has identified the following non-scientific conceptions:

- Phenomena such as bubbles are simply effects: they are not seen in terms of the formation of substances. Thus, the categories of ‘substance’ and ‘effect’ can be interchangeable. ‘Mixing things makes them fizz’—end of story.
- A chemical reaction is not an interaction of ingredients, but one ingredient that plays an active role.

- Substances have an ongoing history, so that a gas formed in a chemical reaction is thought to have been present in some form in the initial ingredients, and that carbon formed from burning is in fact a burnt form of the original substance.
- A candle, when it burns, simply melts, or changes to vapour in the air. Thus, there is a tendency to think of reactions in terms of physical change.
- Oxygen or air is an enabling ingredient in the burning process, but is not consumed in the process.
- Reactants retain their identity in a chemical reaction.
- Gases have negative weight.
- Effects that are due to gases, such as carbon dioxide extinguishing flames, are due to more visible effects such as bubbles.

Activities

Gas and bubbles

Key ideas: In a chemical reaction substances change to new substances, with entirely different properties. Substances can totally change in a chemical reaction. A gas can be formed in a chemical reaction

Teaching note: Clip-lock sandwich bags are ideal for showing gas production as they can be quickly sealed.

The *Where did the sugar go?* activity is merely included to emphasise that the bicarb soda effect is very different to a dissolving phenomenon. Students should be encouraged to use the word ‘dissolve’, and to think of this as total breakdown of the sugar grains and dispersal of the sugar into the vinegar. This is a physical change, and in principle reversible.

The *Froth and bubbles* activity demonstrates a chemical reaction between the baking soda and the vinegar. The quantities suggested inflate the bag nicely, but you may have to deal with demands to try the experiment again using much larger quantities. It is quite possible to blow a hole in the bag with greater amounts, and no real harm will be done. This is an acid–base reaction to form water and a salt (sodium acetate) and carbon dioxide. The questions are designed to draw attention to the fact that the substances are no longer the same. Students might try, after the fuss has settled, to add more bicarb to see if any vinegar is left. Or add more vinegar to see if any bicarb is left. If they smell inside the bag they will notice the vinegar smell has almost gone. What is left is a salt dissolved in water. The vinegar and sodium bicarbonate no longer exist, but their constituent atoms now form the basis of quite different materials.

Students understandably will have trouble with this idea. Younger students (up to age ten or so) tend to say ‘The baking soda caused the bubbles’ or ‘The vinegar caused the bubbles’, treating the reaction as the result of their action in adding the active substance. It is important to emphasise the idea of the substances interacting to cause the effect. They will also need convincing that the vinegar and baking soda are now gone. They will argue that the blowing up of the bag was due to the bubbles, rather than a gas as such with a material

presence. The confident grasp of the gas concept is difficult for students even into upper levels of primary school.

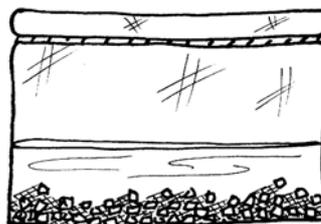
ACTIVITY:
WHERE DID
THE SUGAR
GO?

Key idea: Substances can dissolve in liquids with no visible trace of their presence.

You will need:

- a clip-lock sandwich bag
- vinegar
- sugar
- a cup measure
- a teaspoon.

Measure a quarter of a cup of vinegar into a clip-lock sandwich bag. Add a flat teaspoon of sugar, and shut the bag. Mix the sugar and vinegar around.



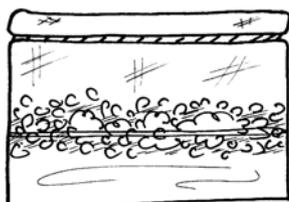
What did you find? Where has the sugar gone?

ACTIVITY:
FROTH AND
BUBBLES

Key idea: Substances can dissolve in liquids with no visible trace of their presence and gases may also be created.

You will need:

- a clip-lock sandwich bag
- vinegar
- baking soda
- a cup measure
- a teaspoon.



Measure a quarter of a cup of vinegar into a clip-lock sandwich bag. Add a flat teaspoon of baking soda, and quickly shut the bag. What happens to the baking soda? Where has it gone? What has happened to the vinegar? Has it changed?

ACTIVITY:
BALLOON
BLOWOUT

Teaching note: This activity allows further exploration of how a balloon full of carbon dioxide might behave compared to a balloon of air. The carbon dioxide is more dense than air, and the balloon is heavier. It falls more quickly to the ground than an equivalent air-filled balloon.

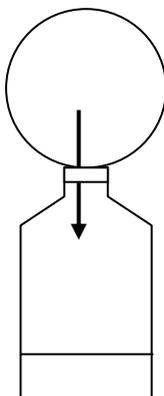
Key idea: Carbon dioxide and air have different properties.

You will need:

- a small plastic soft-drink bottle
- a balloon
- a spoon
- a funnel

- vinegar
- baking soda.

Pour vinegar into a small plastic soft-drink bottle, to a depth of 2 to 3 cm. Put a teaspoon of baking soda into a balloon (you could use a funnel) and fit the mouth of the balloon tightly over the mouth of the bottle. Up-end the balloon to allow all the baking soda to fall into the vinegar.



What causes the balloon to blow up? What has happened to the baking soda, and the vinegar? What is in the balloon?

Take the balloon carefully off the bottle, sealing it and tying it. Blow up another balloon to the identical size. Both balloons are not full of gas, and you can compare them.

Do they feel the same? Do they drop at the same rate?

ACTIVITY:
CORK ROCKET

Teaching note: This activity causes quite a stir. You need to have a good cork with no imperfections, so that gas won't fizz out before the pressure builds up sufficiently to blow the top. Don't point it at anyone, and keep your eyes out of the way! Safety goggles would be a good idea.

Key idea: Gases produced from a chemical reaction can create a large pressure in a confined space.

You will need:

- a glass soft-drink bottle
- a tight-fitting cork
- a teaspoon
- a tissue
- vinegar
- baking soda
- safety goggles.

Pour vinegar into a glass soft-drink bottle to a depth of 2 to 3 cm.

Wrap a teaspoon of baking soda in a small amount of tissue. Place it in the bottle and quickly put the cork in tightly.

What do you think will happen? Can you explain why the cork flies off?



ACTIVITY:
CRAZY
CURRANTS

Teaching note: All the activities with baking soda are based on the same principle, but the bubbles are used for different purposes. The *Crazy currants* activity will go for quite a while, and is great for close observation. Bubbles formed by the reaction adhere to the currant surface and act as rafts which float

the currants to the surface. Once they reach the surface the bubbles pop, releasing the carbon dioxide to the air, and the currants fall again.

In the *Saline* and *Sherbert* activities, the active ingredients are the citric acid and the baking soda, which create carbon dioxide once they dissolve in water and are able to react. Students will not readily associate the fizz of the sherbet with the production of a gas.

Key idea: Gases may be a product of a chemical reaction.

You will need:

- a small jar or glass
- a spoon or icy-pole stick
- vinegar
- currants
- baking soda

Fill the small jar with vinegar, so it is three-quarters full. Put in six currants. Do they sink or float?

Use an icy-pole stick or spoon to put in a small amount of baking soda, and stir. Look carefully at what is happening to the currants. Why are they going up and down?

What is causing the bubbles? What is in the bubbles? What has happened to the baking soda? Is it still there? What has happened to the vinegar?

Once the bubbles stop, how can you get them started again?



ACTIVITY:
SALINE

Key idea: Gases may be a product of a chemical reaction.

You will need:

- icing sugar
- citric acid crystals
- baking soda
- drinking glasses
- a teaspoon
- water.

Make up a powder of:

- a teaspoon of icing sugar
- half a teaspoon of citric acid crystals
- a quarter of a teaspoon of baking soda.



Mix these together, and stir a teaspoon into a glass of water.

What happens? Where has the powder gone?

Try a small amount of each of the ingredients in some water by itself. What happens in each case? Which combination of powders causes the fizz?

ACTIVITY:
SHERBERT

Key idea: Gases may be a product of a chemical reaction.

You will need:

- icing sugar
- citric acid crystals
- baking soda
- icy-pole stick.

Make up a powder of:

- a teaspoon of icing sugar
- half a teaspoon of citric acid crystals
- a quarter of a teaspoon of baking soda.



Mix these together and use an icy-pole stick to put a small amount on your tongue.

What do you think is causing the fizz? Do any of the powders on their own cause a fizz?

Explanatory note: The mixture will fizz on the tongue because of the reaction between the bicarb and citric acid, once saliva dissolves them. The fizz is caused by the release of the carbon dioxide. Investigate which combination causes the fizz.

ACTIVITY:
ALKA-SELTZER
ACTION

Key idea: Carbon dioxide extinguishes a flame and is heavier than air.

You will need:

- a small jar, with a candle that comes to just (1 cm) below the rim, and water in the bottom.
- an Alka-seltzer tablet
- matches
- water.

Light the candle that is standing in the jar. Break an Alka-seltzer tablet into four pieces and carefully drop the pieces into the water.

What do you see? What is causing the bubbles? What is in the bubbles? Why does the candle go out?



Explanatory note: In this activity, carbon dioxide is produced once again. If you look on the ingredients description of Alka-seltzer you will see that they include citric acid and sodium bicarbonate, which react when dissolved in water. The trick can also be done with baking soda and vinegar, and using

vinegar instead of water with the tablet hastens the reaction. The carbon dioxide produced is heavier than air, and gradually builds up in the jar until it snuffs out the candle. This trick also works with bicarbonate of soda, if the candle is standing in vinegar. The carbon dioxide in the jar can be poured onto another lit candle, to snuff it.

Students, of course, will have other ways of explaining this. We worked with teachers of Years 1/2, 3/4 and 5/6 students to run a unit on bubbles which included some of these activities. A couple of months later we ran this Alka-seltzer trick with the same students and asked them to write down their ideas. The table below gives the percentage of each year level giving different explanations.

TABLE:
DIFFERENT
EXPLANATIONS
FOR CANDLE
GOING OUT

Explanation for candle going out	Year 1/2 n = 24	Year 3/4 n = 26	Year 5/6 n = 22
Carbon dioxide was produced	0	0	18
Reference to gas produced	0	12	32
Because of the air in the bubbles	4	23	9
Because of the bubbles, wetness, vinegar, powder, other ...	96	65	41

It is clear that the younger students focus on the perceptual features of the activity, and it is only the upper-primary students who have a reasonably confident grasp of the idea of a gas being produced.

The burning candle

ACTIVITY:
HOW DOES A
CANDLE STAY
ALIGHT?

Key idea: Burning is a chemical change involving the production of new substances.

You will need:

- a dinner candle
- a knife
- wax from a chopped-up candle
- string
- matches.

Make as many observations as you can to answer the questions:

- How does a candle stay alight?
- What is burning?

Look at the candle carefully. Make a list of the things you can see.

Light the candle. What is changing? Can you notice any clues in the flame? What is the wax doing?

Light a match. Blow out the candle and quickly bring the burning match close to the wick. What do you notice?

Is it the wick that is burning? Hold a piece of string upright and light the top end. Does it keep burning?

Is it the wax burning? Break off a piece of candle wax with a knife. Light it with a match. Does it burn?

Is it a combination of factors? Wrap a piece of string in wax, like a wick, and light it. Watch carefully what happens to the flame as the wax starts to melt. Does it keep burning?

ACTIVITY:
CANDLE IN
A JAR

Teaching note: In this activity students may refer to the oxygen running out or being used up. Sometimes they think the oxygen has been driven out of the jar by the candle. Questions such as ‘What has happened to the oxygen ... Where has it gone?’ can produce some interesting responses. The essential science understanding is that oxygen has reacted with the wax under the high-temperature conditions in the flame, and is used up.

The time taken for the candle to extinguish is complicated by the fact that it will go out not when the last oxygen in the jar is gone, but when the flame no longer has access to oxygen because of its replacement with carbon dioxide. The carbon dioxide, although it normally is more dense than air, rises to the top of the jar because it is hot. The jar fills with carbon dioxide from the top down. Therefore the tallest candle in the jar will go out first. The time taken for a candle to go out will be roughly proportional to the volume of the jar if a short candle is used.

You will find that the candle will go out eventually, provided the rim of the jar sits slightly lower than the flame. The carbon dioxide collects in the jar even though it is open to the air.

The last part of the activity is sometimes done with the jar standing in water. Water is drawn up into the jar as the candle goes out. The heated air from the candle flame expands, taking up space. However, when the flame is extinguished the air cools and contracts. The water fills the contracting space.

The simple answer to the question ‘Why does the candle go out?’ is that the oxygen is used up. Test the details of this hypothesis by investigating the time taken for a candle to go out under different conditions.

Key idea: The burning reaction requires oxygen as one of the reacting substances.

You will need:

- **candles of various heights**
- **matches**
- **glass jars of various sizes**
- **a mat to place the candle on.**



Light a candle and put the lit candle on the mat. What do you think will happen if you put a glass jar over the top of the candle? Try it and see. Why did the candle go out?

Look at the bottom of the upturned jar. What can you see? What caused the blackening? What is the black stuff? Where does it come from?

What does a candle need to keep burning?

Vary the volume of the jar. Does a candle stay alight twice as long if the jar volume is doubled? Try three candles of different heights in the same jar. Predict if they will go out at the same time. Try it—observe. Explain.

Does the jar need to be sealed at the bottom? Hold the jar above the surface, with the rim just below the flame. Does the candle still go out?

Explanatory note: The candle is an elegant example of many science ideas involving both physical and chemical change. Very few adults will be able to explain the process straight off, but the sequence of challenges in the candle activity give some good evidence for what is really happening. This activity shows the detective work in much science investigation. It involves looking for evidence to support or refute views of what is happening.

Students will often claim that the wax in the candle is simply there to hold it up or slow down the burning of the wick. The notion of the wax as a fuel is not apparent. They will also argue that the amount of wax that drips accounts for all the wax that was in the candle to begin with. They need to be talked through the idea that the wax is used up as the candle goes down, and this has to do with what is burning.

Even though the wax is the fuel, the wick is critical in the process. But the wick will not burn by itself, as trying to burn an upright string will show. If the string is touching a lump of wax, the flame springs to life and attains a different character once it burns down to touch and begin to melt the wax. The wax first melts when the candle is lit. It is then soaked up the wick by a process of capillary action. Spreading out in the flame, it will vaporise. We thus have a solid–liquid–gas transition. It is the unburnt wax vapour around the candle that will relight if a match is quickly brought close immediately after the candle is blown out.

The wax vapour is heated in the flame to the point that it reacts with oxygen in the air. It burns. The products of burning are carbon and carbon dioxide and water vapour. The carbon and condensed water vapour can be seen on the inside of the jar put over the top of the candle in the following activity.

ACTIVITY:
CANDLES AND
WATER

Key ideas: Air expands on heating. The products of burning include oxygen and water vapour.

You will need:

- a candle
- matches
- a dish of water
- a jar.

Stand a lit candle in a shallow dish of water. Place an upturned jar over the candle quickly, standing it in the water.

Observe carefully the sequence of events. What is happening?

Explanatory note: The candle goes out once the oxygen in the air is consumed. Why does the water rise up in the jar? The traditional explanation is that it rises to replace the 20% of air that is oxygen, now consumed by the flame. However, this cannot be correct since carbon dioxide is one of the products, and replaces the oxygen by volume.

The water rises due to these factors:

- The initial expansion of air due to heating from the flame forces air to bubble out the bottom. Once the candle goes out and it cools, it contracts again, reducing the pressure and the water is drawn up into the jar.
- One of the products of the reaction is water, which is formed as vapour and the pressure from this gas forces air out. Once the air cools as the candle goes out, this water vapour condenses on the side of the jar, reducing the pressure and drawing the water up.
- Depending on the acidity, the water may absorb carbon dioxide and that would reduce the pressure also.

You will notice that the sequence of events and the height the water rises will differ depending on how quickly the jar is put over the candle. If it is left above the flame before being lowered, the air inside will heat up. Can you use this idea to explain the difference you observe?

Acid–base indicators

ACTIVITY:
CABBAGE
COLOUR
CHANGE

Teaching note: A different type of surprise event can be engineered using acids and bases and an indicator that changes colour. Red cabbage can be boiled up to produce a good amount of indicator that varies in colour from red, if an acid is put in, to blue-green for a base. Household products (such as cleaners and washing products, cooking powders, fruits and their juices, spices, hair products, salt, vinegar, tea and coffee) can be tested using this indicator.

Key ideas: Substances can be classified on an acid–base scale. An indicator is used to measure acidity. Acids and bases can react to neutralise each other.

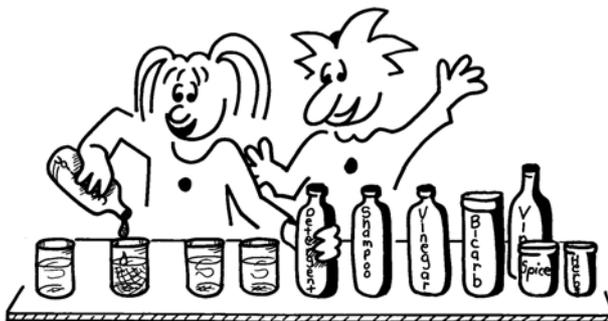
You will need:

- red cabbage
- water
- a saucepan and a stove or hotplate, or an electric frying pan
- a variety of household products (e.g. cleaners, washing products, cooking powders, fruits and their juices, spices, hair products, salt, vinegar, tea and coffee)
- jars or plastic cups.

Make some indicator by boiling red cabbage. Place the substance (household product) to be tested in a plastic cup or a jar and add indicator. Record the resultant colour change on a table.

Can the indicator colour be changed back to its original shade? Leave students to attempt to solve this problem.

Have each student test a substance and then share their information with others in a group.

**ACTIVITY:
WATER TO
WINE****You will need:**

- three identical drinking glasses
- red cabbage juice
- water
- lemon juice
- baking soda.

Try the following magician's trick. Take three drinking glasses: one with diluted red cabbage juice, one with a drop of dissolved baking soda (sodium bicarbonate), and the other with a few drops of lemon juice. Pour the cabbage juice into the glass with the hidden baking soda. It goes green! Act surprised. Now pour this into the glass with the lemon juice drops. It goes red! Act totally astounded. You can drink this 'red wine' if you like cabbage juice!



Kitchen science

Cooking can introduce a wealth of observations and interpretations of changes to materials. Generally, activities involving heating are not appropriate for students in the early years. However, for young children it is possible for the teacher to demonstrate the cooking process and distribute results to groups for investigation and display. Thus, bread can be baked with a early years school class observing and commenting on each stage, and taking samples of the ingredients and the mixture away to explore and write about.

For most of the cooking activities involving a 'freeze-frame' technique, it is better for groups to explore the changes and displays themselves. These activities are suitable for the middle years.

As a general principle, in these cooking activities we are wanting students to consider the underlying science, so that what is normally thought of as a generalised effect ('cakes rise in the oven') becomes explainable in terms of changes to substances ('gases are produced by a yeast reaction to make cakes rise, the evidence of which can be seen in the texture'). One major question that might be asked of most of these activities is 'why do we heat foods?'. There is no single answer to this question, but each activity provides its own perspective.

The effects of heat include:

- breaking down cell walls to soften food
- killing bacteria (not addressed in these activities)
- allowing yeast to become active
- speeding up chemical reactions
- evaporating water from food.

Effects of heating, in cooking

Consider the following general points:

- What are the reasons for the various effects observed during the session?
- What are some of the scientific principles we would want to bring out in these activities?
- Why do we heat food?

ACTIVITY:
YEAST AND
SUGAR

Key ideas: Yeast causes bread to rise by producing carbon dioxide. Variables need to be controlled to establish causes.

You will need:

- **test tubes or small jars or containers**
- **a teaspoon**
- **yeast**
- **sugar**
- **cold and lukewarm water.**

Yeast is a living organism that produces carbon dioxide. The production of carbon dioxide can be observed as the presence of bubbles.

Explore the action of yeast by mixing a small amount of it with a small amount of sugar, in water. This can be done in a small test tube or glass jar.

Set up a controlled experiment to test the effect of sugar and the temperature of water on the rate of production of carbon dioxide by yeast. (Compare cold with warm water—don't make the water too warm).

ACTIVITY:
SPAGHETTI

Teaching note: You will need to consider what methods of time keeping would be appropriate for different year levels.

When you compare the strands some possible features that could be described are length, texture, colour, width and thickness. The cellular tissue in the spaghetti breaks down on heating. Water is absorbed and the strand expands. A starch substance leaches from the spaghetti into the water.

Key ideas: The effect of heat and water to soften carbohydrate tissue. The use of a 'staged removal' or freeze-frame strategy to track change over time.

You will need:

- a saucepan
- fifteen spaghetti strands
- paper and pencils
- timers

Immerse fifteen identical strands of spaghetti (5 to 10 cm in length) in boiling water. Set one strand aside as the 'zero cooking time' standard.

Take out one each minute and stick the strands alongside each other on a sheet of paper, with their bottom end on a horizontal line, appropriately labelled (to duplicate a bar graph of change over time).

What changes have occurred?

Allow to dry. Does the spaghetti return to its original state?

ACTIVITY:
MAKING
DROPSCONES

Key ideas: The many physical and chemical changes involved in cooking (mixing, dissolving, evaporation, burning, changes to texture). The use of a freeze-frame technique for investigating change over time.

You will need:

- a table or worksheet and pens
- a timer
- a sieve
- basins
- a wooden spoon
- a frying pan and hotplate, or electric frying pan
- a beater
- a spatula
- a measuring spoon and cup
- 2 tspn sugar
- 1 egg

- 1 cup (126 g) self-raising flour
- $\frac{3}{4}$ cup milk
- fat or oil for cooking.

Mix up the ingredients according to the recipe below. As you proceed, note the changes that are occurring in each ingredient. What happens to the fat? Is the flour mixing or dissolving?

Start cooking four to six dropscones of identical size at the same time. Turn and remove them in sequence so that you end up with freeze-frame samples with each side cooked for thirty seconds, one minute, two minutes, four minutes, etcetera.

As the cooking proceeds, note what changes are visible at the top surface of the dropscone. You could remove one with only one side cooked to 'freeze' this process in time.

Construct a table or worksheet to provide a clear record of what happens at the stages of preparation and cooking. Record the changes that occur. Describe these as completely as possible and explain in terms of what is happening to the material. For instance, is the mixing a physical or chemical change? What is causing the bubbles? What is the black stuff?

Dropscone recipe

Makes approximately 12. Use half quantities if possible.

Utensils	Ingredients	Instructions
sieve	2 teaspoons sugar	1 Beat sugar and egg together until creamy.
basins	1 egg	
wooden spoon	1 cup (126 g) self-raising flour	2 Pour creamed mixture over the sifted flour and stir in the milk, a little at a time, beating until smooth.
frying pan and hotplate, or electric frying pan	$\frac{3}{4}$ cup milk	
beater	fat or oil for cooking	3 Heat a little fat in frying pan.
spatula		4 Drop spoonfuls of mixture into hot pan and turn with spatula when mixture begins to bubble.
measuring spoon and cup		

Explanatory note: The changes to materials you will notice include the mixing of flour to form a paste, the change in consistency of the materials, the dissolving of the sugar and the mixing together of the yolk and egg white, the beating of air into the sugar and egg mixture. For the cooking: the melting of fat, the formation of bubbles of steam as the water evaporates and carbon dioxide from the flour being heated, the hardening of the mixture as it lightly burns, the drying of the mixture on the inside of the drop scone as heating proceeds.

ACTIVITY:
MAKING
SCONES

You will need:

- a scone recipe
- a timer
- utensils
- ingredients
- a knife
- an oven
- pencils and paper for sketching.

Make scones and remove one from the oven every three minutes. Observe the changes that have taken place in shape, texture and colour. Use a knife to expose a cross-section of each scone, and sketch this with labelling to clarify what is happening as the cooking occurs.

Construct an illustrated 'story' that describes in detail what happens to the scone after it is put in the oven.

ACTIVITY:
MAKING SOUP

Teaching note—recording strategy: How appropriate is the worksheet format in the table below for the recording of data in the early years? How could you improve this table for use in the middle years?

TABLE:
EXAMPLE OF A
WORKSHEET

Ingredients	Changes caused by cooking			Comments
	Hardness	Size	Colour	
	Harder (H) No change (N) Softer (S)	Smaller (S) No change (N) Bigger (B)	Lighter (L) No change (N) Darker (D)	
Carrot	S	N	L	
Barley	S	B	L	

What design features should we look for in a worksheet? What role does descriptive writing play?

Key ideas: Changes to vegetables over time, due to heating. Freeze-frame method of exploring change over time.

You will need:

- a saucepan and heat source, or electric frying pan
- a timer
- water

- oil
- cooking utensils
- a range of vegetables: onion, carrot, potato, celery, parsnip, beans.

Cut the vegetables into 1 cm cubes (at least ten of each). Chop the onion. Fry onion gently in oil. Describe the changes that occur.

Add water and boil. Predict the order in which the vegetables will soften. Add them to the water at the same time.

Take out a piece of each vegetable at appropriate intervals (e.g. one minute) and lay out for display.

Document changes over time in the vegetables' texture, colour and size, and compare with your predictions. At what point did each soften sufficiently for eating? Was the change slow or sudden?

ACTIVITY:
POPPING CORN

Teaching note: The corn pops as the enclosed water evaporates and expands, causing the corn to effectively turn inside out. Heating gently allows the water to evaporate and escape without the violent rupture of the corn.

Key idea: Evaporation of water.

You will need:

- popping corn
- a frying pan or saucepan
- oil
- a glass lid or heatproof beaker.

Fry the corn in oil. Use a glass lid over the frying pan or saucepan, or place a heatproof beaker over them. Observe the popping corn.

Compare the properties of corn before and after heating. Fill a container with popped corn. How many pieces of popped corn are there? Now compare this total with how many pieces of unpopped corn fill the same container.

Try heating some corn gently, before attempting to pop. Any difference?

ACTIVITY:
DRYING FRUIT

Key ideas: Moisture content of fruit. Evaporation.

You will need:

- apples
- a knife
- an oven.

Prepare dried apple by placing thin slices in an oven. Remove at intervals. How will you record the changes? Do thin or thick slices work best? Why?

ACTIVITY:
CHOCOLATE
CRACKLES

Teaching note: It is best to work in groups, with each group investigating the difference between normal crackles and a different missing ingredient.

Key idea: Cooking ingredients have a purpose related to their properties.

You will need:

- a chocolate crackle recipe
- a mixing bowl and stirrer
- paper cups
- cake containers
- butter
- copha
- cocoa
- sugar
- rice bubbles
- a refrigerator.

Make a few chocolate crackles using a conventional chocolate crackle recipe.

Investigate the result of leaving each ingredient out of the recipe in turn.

Alternatively, replace one ingredient at a time with something you think will serve as well (e.g. Weet-bix instead of rice bubbles).