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# Physical changes to matter

## Introduction

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Many of the activities in this topic focus on counter-intuitive effects, or at least effects that have an element of surprise and charm. Sometimes they are common phenomena, but students are challenged to look at them in new ways. Melting, evaporation and condensation are examples of physical change, or change of state, and are distinct from changes that cause new materials to form through a chemical reaction. Distinguishing between physical and chemical changes is not always easy, particularly if you do not have access to the concept of atoms and molecules. Some curricula talk of physical changes as being reversible, and chemical change being irreversible. Examples of irreversible chemical changes would be the burning of wood, or a candle, or the reaction of vinegar and baking soda to form carbon dioxide, water and a salt. However, while the notion of reversibility is important when discussing changes of state (solid to liquid, liquid to gas, and vice versa), some physical changes are not reversible (such as the separating of butter into its different constituents on heating, or the physical change to a car in an accident), and some chemical changes are reversible (although usually these would require a professional chemist to perform).

## Key concepts of physical changes to matter

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

### Early years

- Substances can be solid, liquid or gas, or mixtures of these.
- Solids hold their shape, liquids flow and settle in containers, gases take up space in containers.
- Melting involves a change from a solid to a liquid, caused by heating.
- For a pure substance such as wax or ice, melting is reversible.
- Some substances, when heated, burn rather than melt, or melt but cannot be changed back (e.g. dairy products).
- Melting is distinct from mixing or dissolving, which involve adding a liquid.
- Water, when it boils and evaporates, changes to steam.
- Water will evaporate at ordinary temperatures, going into the air as a vapour (gas).

### **Middle years**

- Liquids differ in a range of properties, including viscosity (runniness), density and transparency.
- Substances tend to melt at particular temperatures. For pure substances, the temperature is well defined. For substances that are mixtures, the transition may take place over a range of temperatures.
- Evaporation involves a change from the liquid to gas state, and condensation is the reverse of this.
- Fog or water appearing on cold surfaces is due to condensation of water vapour from the air.
- When substances dissolve in a liquid, their molecules intersperse amongst those of the liquid.
- Different substances will dissolve in different liquids.
- When substances form a mixture in a liquid rather than dissolving, they may remain as small solid particles (as with dust).
- The forms that substances can take are complex and varied, including suspensions and colloids, mixtures, etcetera.. As such they can be hard to classify.

### **Students' alternative conceptions of physical changes to matter**

Ideas about changes to matter are influenced by quite fundamental views about the nature of matter. Students' concept of 'matter' can be very different to adult views. Young children will not, for instance, be very committed to the idea of matter having a continuing existence during changes, and will quite happily talk about clothes 'drying up' without being very interested in what has happened to the water in that case. They are more attuned to effects than to charting the changes to matter that accompany these effects. Similarly, they will put entities such as heat, or properties such as coldness, in the same category as dampness or fog. They can say things like 'the coldness turned to fog', which avoids the need to consider where the material that makes up the fog may have come from.

The task of the adult, therefore, in engaging students in these activities, is to learn to listen for these ambiguities in language, and to ask questions that challenge the children to focus on what is happening in terms of changes to matter, and to model through the discussion the language of these changes.

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

- Only objects that are 'hard' and cannot be changed in shape are solid.
- Substances can disappear or be interchangeable with entities like heat.
- Melting involves substances turning to water.
- Melting and mixing with water are confused.
- Water can simply 'dry up' in the sun, or can be 'overcome by the strength of the heat'.
- Water in puddles evaporates into the sun.

- Water appearing on cold bottles is simply coldness turning to fog, or it may be water leaching through.
- The smell of liquids such as perfume is separate from any physical material.
- Dissolving is confused with melting.

## Activities

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### Solids, liquids, gases

ACTIVITY:  
SUBSTANCE  
LINE-UP

**Teaching note:** Many words in the language are associated with ‘solid’, such as ‘hardness’, ‘heaviness’, and also ‘melting point’, and these confuse the simple judgment about whether a thing is solid or not.

Powders also give difficulty. The trouble with the language is that in science we talk of substances as being solid, whereas in common everyday language we might think of objects as having solid properties. Thus, while the substance sand might be solid, a jar full of sand is runny. Young children find it difficult to separate an object from the material it is made of. Thus, they may think that a candle, when ground, is different in substance.

Where the dividing line between solid and liquid should go is complex. Is flour a solid? (Yes.) Is toothpaste? Glass is a liquid in some senses because over a long period of time it will run. An old window will be thicker at the bottom than the top because of this. It can be difficult to decide if a substance is a mixture rather than a pure substance.

**Key idea:** Substances have a variety of properties and mixtures can be difficult to classify, but all pure substances can exist as solids, liquid or gases. Solids maintain their shape, liquids flow and settle in a container, and gases fill the container.

**You will need:**

- a number of labelled clear-plastic containers that enclose a variety of materials (e.g. Vegemite, water, hundreds and thousands, shaving cream, aluminium foil, wood, wool, plastic beads, etc.).

**Line up the samples provided from ‘most solid’ to ‘most liquid’. Attempt to decide what criteria to use to establish where the line between solid and liquid should go. Discuss how to define ‘solid’ and ‘liquid’.**

ACTIVITY:  
LIQUID  
LINE-UP

**Teaching note:** Examples of properties are degree of colour, runniness, smell, transparency, where used, mixability with water. In the last exercise students should be encouraged to devise measurement procedures and criteria such as for surface tension, measuring the number of drops that fit on a coin, or looking carefully at the shape of a drop—the angle at the surface is a measure of the surface tension.

**Key idea:** Liquids can be classified according to a range of properties.

**You will need:**

- a series of clear containers with a variety of liquids inside (detergent, oil, water, glycerine, methylated spirits).

**Put the liquids provided into groups according to their properties.**

**How many criteria could you use?**

**Choose some properties (e.g. runniness, transparency, surface tension) for which you can set up a measurement. Carry out measurements and set up a table showing the difference between the liquids.**

ACTIVITY:  
LIQUID RACE

**Teaching note:** For the speed down the tile, the easiest method is to put a drop of each liquid along one edge of the horizontal tile, and tilt it for a set time. Measure how far each liquid has flowed. Think about what controls are needed.

**Key idea:** Liquids have different degrees of ‘runniness’ that can be measured in different ways.

**You will need:**

- a tile
- a chinagraph pencil or other marker
- a set of different liquids (e.g. water, methylated spirits, honey, detergent)
- a small funnel.

**Devise a way of comparing the viscosity (runniness) of the liquids using a measurement process that will enable you to enter numbers in a table. Some suggestions of method:**

- the speed at which the liquid flows down a tile
- the rate at which it flows through a funnel
- the time it takes for the liquid to settle when the container is turned upside down.

## Melting

ACTIVITY:  
TESTING  
TEMPERATURES

**Key idea:** Appreciation of the temperatures we encounter in everyday life.

**You will need:**

- thermometers
- strips of paper
- sticky tape.

**Tape a strip of paper to an ungraded thermometer, and over the period of a lesson construct a temperature scale based on temperatures you come across (hot water, ice, near window, etc.). Mark and label each point on the temperature scale with its sample situation.**

**ACTIVITY:  
MELTING ICE**

**Teaching note:** The trick in melting the ice is to get heat into it as quickly as possible. Immersing it in hot water is very quick, but too easy, and it's best not to allow that option. Interestingly, heating in a frying pan is not as quick because the heat in that case is applied to the bottom surface only. Smashing the ice, then heating it in some way (e.g. putting it in a few mouths), works well because the fragmentation increases the surface area of the ice exposed to heat (think of all the surfaces opened up to let heat in that were embedded in the ice before). Pressure also works. The trick with the warm cloth and foil is that these act as insulators and actually slow down the melting. Students will think of blankets as supplying warmth but that is an overextension of their experiences as bodies with internal heating sources.

A variation on this challenge involves students needing to present you with the melted ice water as proof of the completion of the process.

**You will need:**

- ice cubes
- aluminium foil
- a cloth
- water
- a wooden mallet.

**The challenge is to plan for and test ways of making an ice cube melt quickly. You must be able to demonstrate that all the ice has melted.**

**As part of the planning you might discuss the advantages and disadvantages of the following strategies:**

- wrap it in aluminium foil
- wrap it in a piece of warm cloth
- put it in your mouth
- put it in the sun
- put it in room-temperature water and stir
- pass it from person to person to squeeze in the palm of your hands.
- smash it with a mallet.

**You will be given two ice cubes to compare two strategies. Decide on your plan. Get your materials together. Be clear about your reasons. On your blocks ... ready ... GO!**

**ACTIVITY:  
LIFTING AN  
ICE CUBE ON  
A PIECE OF  
STRING**

**Key idea:** Salt and other additives can lower the temperature of ice.

**You will need:**

- ice cubes
- a bowl of water
- string
- salt.

**Float ice cubes in a bowl of water and cut some string about 20 cm long. Challenge a friend to use the string to get the cubes out of the water without touching them.**

**Here's how you do it:**

- **Moisten one end of the string and rest it on the surface of the ice cube. Sprinkle some salt on it. Wait a little while for the ice to melt around the string and then freeze over again, trapping the string.**
- **Lift the ice cube gently out of the water.**

ACTIVITY:  
ADDING SALT  
TO ICE

**Key idea:** The details of the freezing process.

**You will need:**

- salt
- a bowl of crushed ice
- test tubes
- orange juice
- water
- a thermometer
- a timer.

**Add salt to a bowl of crushed ice. Check what happens to the temperature. Take (a) a test tube of orange juice, and (b) a test tube of tap water, and place them in the crushed ice. Observe what happens to them over time as they begin to freeze.**

**What happens first? What is the sequence of events as they freeze? Design a sheet by which you can record (serial recording) the freezing process. Take the test tubes out at intervals, and describe the changes that take place. (Where does it freeze first?)**

ACTIVITY:  
MELTING  
DIFFERENT  
ICES

**Key idea:** Different mixtures will have different properties when frozen, and different melting rates.

**You will need:**

- containers of different liquids such as milk, black coffee, lemonade, brine, orange juice
- a freezer.

**Put the liquids in a freezer for a day.**

**Devise a method to compare their hardness. Do they differ in hardness?**

**Predict which will melt first. Take them out of the freezer to compare their rate of melting. Were you correct?**

ACTIVITY:  
THE BIG MELT

**Teaching note:** In this activity, do not allow the substances to mix together in the frying pan, since they can interact and spit. There are many things to discuss about this activity, but a main issue is the order of melting, which will line up the substances in order of melting point, from lowest to highest. They should solidify (freeze) in the reverse order. This judgment is best made according to when the substance first starts to melt rather than when it is completely melted, since other factors such as size or heat conduction will affect that. The observations will be complicated because, for instance, the chocolate softens in

interesting ways but does not become 'runny' like the butter. The language can be misleading here.

The butter and cheese will melt, but because they are mixtures of substances (water, fats, milk solids) the melting point is not clean and they tend to separate out somewhat. The cheese burns easily. The sugar caramelises to form a toffee, which is a chemical burning reaction. The question of reversibility thus becomes an obvious talking point.

Younger students can argue that the wax and copha, when they have solidified, are different because the shape is different. Part of the conceptual agenda here is to encourage them to think about the substance itself being distinct from the object it forms. Children do not readily make this distinction.

**Key idea:** Substances have different melting points, which are also the temperatures at which they freeze.

**You will need:**

- aluminium electric frying pans (or conduct the activity one substance at a time in a single frying pan, but do not mix the substances)
- small aluminium containers with 1 cm cubes of chocolate, butter or cheese, copha, ice, candle wax and sugar.

Place each of the different substances in a separate small aluminium frying pan. If they are heated in a frying pan, which do you think will begin to melt first?

Predict the order of melting. Now try it.

Predict which order you think they will turn to solid when the heat is turned off. Can they all become the same as they were before when they cool down?

What happens to a substance when it melts? Some of them change colour. What has happened to them?

Why can't they be made to go back to the same as before?

**Key idea:** The composition of butter and its relationship to cream.

**You will need:**

- thickened cream
- a glass marble
- a glass jar.

Put 60 mL of thickened cream and a glass marble in a glass jar or vial. Shake until butter forms.

What else do you notice?

Does the temperature of the cream make any difference?

Does the butter taste the same as commercial butter? Why?

ACTIVITY:  
MAKING  
BUTTER

## Evaporation

Every day evaporation is taking place around us and water falls from the sky in the form of rain, hail or snow. These activities focus on the water cycle and the role of evaporation.

**Teaching note—concerning evaporation activities:** Students will explain evaporation phenomena at various levels. You will find they will give different explanations depending on the activity. For instance, a child may say that the disappearing handprint dried up into the towel, that the puddle went up to the sun, and that the clothes dripped on the ground to make the flowers grow. Each circumstance triggers different images, and other ideas creep in. We worked with the teacher of a preparatory class to run the puddle activity. The students were astounded by its disappearance.

- Walter thought the puddle had gone into a cloud because when he looked up later in the day he saw a cloud with the same shape as the puddle.
- Kaye told us a year later about having to draw chalk lines wider and wider as she poured the water and it spread on the asphalt.
- Rosalie thought the heat from the sun was stronger than the puddle and it dried up.
- Amy thought the water floated round in a shady spot and then went to the sky to make rain in a place away from the sun. She also thought it went into a drain under the school.

The idea of the water cycle is often taught to young children, but they tend to misinterpret it, often thinking that water rises straight to the sun which passes it to the clouds, or at least not having any idea about the role of the atmosphere in the process. We found that young students had difficulty with evaporation largely because they were not particularly interested in tracing what happened to water once they could no longer see it, and also because they did not have a clear understanding that air surrounds us, let alone that it can support water vapour. Their understanding of how the atmosphere, clouds, the sun and Earth relate to each other was also a problem.

Even older children can have ambiguous views about material water, and can think of the dampness of clothes as somehow distinct from the water they might contain. The explanations below illustrate different levels of understanding of evaporation:

- the water has dried up
- the water has soaked into the ground (or clothes, or cloth)
- the water has gone up to the sky to form clouds
- the water has gone into the air
- the water has changed to vapour (or moisture or steam) in the air.

ACTIVITY:  
WATCHING  
WATER BOIL

**Teaching note:** Watching water boil might seem like the equivalent of watching a fly crawl up a wall. Don't bet on this activity, but there are surprises! The bubbles appear in stages and in interesting ways. The first bubbles appear quickly at the edges, and these are actually dissolved air coming out of the solution. Water always tastes flat when it has been boiled because of



the lack of dissolved air. Nor would it be a good idea to use boiled water in your fish tank!

The next phase will be bubbles that are small and appear where the heat is applied from below. These grow and detach, then disappear before hitting the surface. What is in these bubbles? Steam! The water changes to pockets of vapour as it is heated at the pan bottom. Most students (and adults) will claim there is air in the bubbles. Not true. Some will also argue there is hydrogen and oxygen in the bubbles from the dissociation of the water, but it would take much more energy than supplied in the frying pan to cause this to happen. This is a liquid-to-gas change.

Gradually, the bubbles become bigger and burst to the surface, releasing the vapour to the atmosphere. The water level drops as the water changes to steam. Young students, while they recognise the steam, do not associate it with the dropping water level. They may argue that the water simply boiled away. One teacher we worked with challenged her Year 6 students to work out how to get the water back. They came up with a suggestion to put cans around the room with ice in them, so the vapour could collect on the can surfaces!

**Key idea:** When it boils, water changes to water vapour in the air. The bubbles are steam.

**You will need:**

- a small pan and a hotplate or an electric frying pan
- a mirror.

**Put a small pan of water on a hotplate or put water in an electric frying pan. Watch carefully what happens. Where do the bubbles come from?**

**Put a mirror over the boiling water. Why does the mirror fog up?**

**What happens to the water when it boils?**

**Draw a picture to show what is happening to the water.**

**Key idea:** Water evaporates and becomes vapour in the air in the room.

**You will need:**

- a small chalkboard, or paper towel
- a pen.

**Wet your hand and lay it on a piece of chalkboard, or a paper towel.**

**Leave it for a while, and observe what happens.**

**What happens to the water?**

**Where does the water go?**

ACTIVITY:  
DISAPPEARING  
HANDPRINT

ACTIVITY:  
PUDDLES ON  
THE SCHOOL  
GROUND

**Key idea:** Evaporation of water to become vapour in the air.

**You will need:**

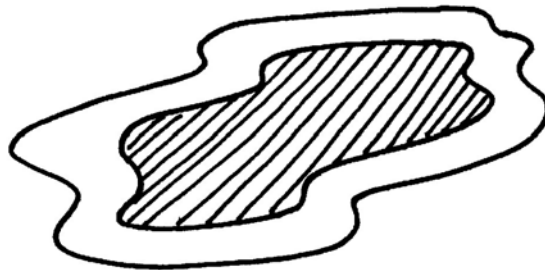
- a depression in asphalt or concrete
- water
- chalk.

Rory's class was doing a science experiment about puddles of water in the school grounds. After a shower of rain the sun came out, but there was still a big puddle on the asphalt near the classroom. Rory drew a chalk line around the puddle to trace its shape. The students went inside to write down their prediction of what would happen to the puddle. When they came out again they found that the puddle had shrunk. Later in the day when Rory looked, the puddle had disappeared. Rory's teacher told him that puddles always shrank and eventually disappeared, even on hard surfaces like concrete.

What has happened to the water in Rory's puddle?

Where does the water from the puddle go?

Try this yourself with a puddle and some chalk.



ACTIVITY:  
WATER IN THE  
TANK

**You will need:**

- a bowl of water
- a texta
- a jar with a lid
- some plastic wrap

Annabelle has a fish tank that she looks after carefully. She noticed that even before she put fish in it, the water level went down each week so that she had to top it up. She checked carefully for leaks, but there were none. She asked her older sister, who said 'The level of water in a tank will always go down even if it does not leak'.

What happens to the water in Annabelle's fish tank? Where does the water go?

Try this yourself by putting water in a bowl and marking the level with a texta. Leave it for a week in a place you are sure it won't spill, and the cat won't drink it. To help check what happens, you might try the same thing with a jar with a lid, or a bowl with some plastic wrap over the top.

ACTIVITY:  
WHICH  
EVAPORATES  
FASTEST?

**Key idea:** Substances evaporate at different rates. Evaporation rate is affected by temperature, wind, etcetera.

**You will need:**

- water and methylated spirits
- ceramic or glass tiles
- a hairdryer
- a fridge.

Place drops of different liquids (e.g. meths and water) onto a ceramic tile and see how quickly each evaporates under various conditions (e.g. open air, hairdryer, fridge, under a cover).

ACTIVITY:  
EUCALYPTUS  
JAR

**Key idea:** When they evaporate, substances disperse as vapour in the air in the room. Mostly the dispersal occurs through convection currents.

**You will need:**

- a bottle of perfume or eucalyptus oil, or a can of air freshener.

Open a bottle of perfume or eucalyptus oil (or spray air freshener) and trace the development of the smell through the room by asking people to put their hand up when they can smell it.

**How do we smell things? What happens to enable us to smell the oil or the perfume?**

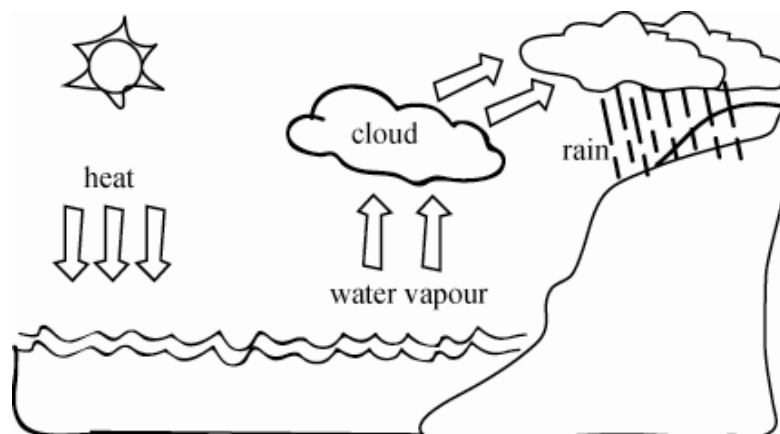
Draw what the oil must look like, in the room, in order for people to smell it. Use the idea of molecules if it makes sense to you.

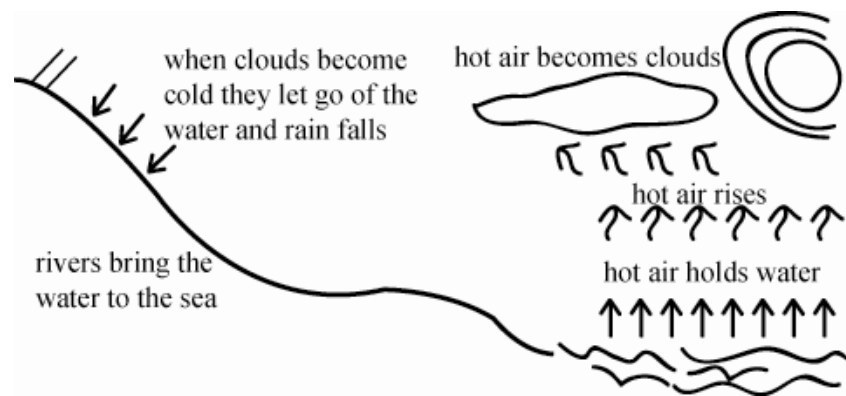
What do we mean by a 'gas'? How is it different to a 'liquid'?

## Water cycle diagrams

The figure below shows diagrams of a type commonly found in textbooks to illustrate the water cycle. The diagrams contain a number of ambiguities or inaccuracies.

FIGURE:  
WATER CYCLE  
DIAGRAMS





## Condensation

ACTIVITY:  
COLD, WET  
CAN

**Teaching note:** Condensation phenomena are more difficult for students to explain than evaporation, possibly because condensation requires a clear commitment to the idea of air as holding water in some form. The idea of water coming out of the air is more challenging than that of air soaking up the water. In this activity, students will commonly refer to the water that appears on the outside as coming through the can from the ice, or as the coldness coming through and changing to dampness. Younger students will argue that the can leaks, and will need to be convinced that the fog that appears is in fact water and not some visible correlate of coldness. We have done this with a cold bottle taken out of a refrigerator, only to have students argue that the water followed from the refrigerator!

At the lowest level, students will commonly associate dampness with coldness, and leave the explanation at that. Older students will also argue that fog or steam is caused by clashes of hot and cold. It is important to establish that the question ‘what causes the fog?’ is really the question ‘where does the water come from?’, and the prior existence of that water is a matter of interest.

**Key idea:** Condensation is caused by water vapour in the air turning to water on the cold surface.

**You will need:**

- a steel can with a shiny surface, and preferably a lid
- ice cubes
- cold water.

Put about ten ice cubes and some cold water into a dry can, and put the lid on. Predict what will happen to the outside of the can.

Leave it for a while, but check what is happening. What happens? Why does it happen?

You can also try this with a cold bottle taken out of a refrigerator.



**ACTIVITY:  
COLD MIRROR**

**Key idea:** Condensation is caused by water vapour in the air turning to water droplets on the cold surface.

**You will need:**

- a mirror
- a freezer.

**Put a mirror in the freezer for half an hour.**

**Take the mirror out, and look carefully at what happens as you pull it out (you'll have to observe closely, as it happens very quickly). What is on the mirror surface? Where did it come from?**

**Breathe on the mirror. Can you explain what happens now?**

**ACTIVITY:  
WATER FROM  
LEAVES**

**Key idea:** As part of the photosynthetic process, water evaporates from plants' leaves to become water vapour in the air.

**You will need:**

- a plastic bag
- a leafy tree.

**Place a plastic bag over a group of leaves on a tree and tie the bag in place. Return after about one hour. What can you see? Explain your observation.**

**Would you collect more water during the day or during the night?**

**ACTIVITY:  
SOLAR STILL**

**Key ideas:** Leaves contain water which evaporates to become vapour in the air. The vapour can change to water on meeting a cold surface.

**You will need:**

- fresh leaves
- a pan
- plastic wrap
- a support structure.

**Create a solar still; designs can be found in many books, and on the Web (e.g. <<http://www.aris.com.au/sciweb/activity/AC/conservwat4.html>>, <<http://www.nap.edu/readingroom/books/rtmss/3.52.html>>). The essential features are plant material, plastic wrap arranged above for the vapour to condense on, and a pan to collect drips from this.**

**Where does the water that collects come from?**

**Draw a picture of the cycle.**

ACTIVITY:  
CONSTRUCTING  
A TERRARIUM

**Key idea:** Water from plants is converted to water vapour in the air, which condenses on the cold sides of the terrarium. There is a water cycle within the terrarium.

**You will need:**

- a small glass aquarium or large glass container
- potting soil
- plastic wrap to seal the terrarium
- small plants.

Set up the terrarium with the lid covered, without watering the plants. Starting with moist soil is enough.

Predict what will happen to the plants.

Observe over time what happens in the terrarium. What is causing the water drops on the inside of the glass?

Draw a picture of what is happening to water in the terrarium.

## Dissolving

Children are often confused about what constitutes dissolving (one substance combined with another) and melting (a change of state as a result of heating). This confusion is embedded in some metaphorical language ('She dissolved into tears'). Children will be familiar with many instances of dissolving, mixing and melting which can be drawn on to clarify the distinction and sharpen their understanding of what is happening.

ACTIVITY:  
DROPS ON  
SUGAR

**Teaching note:** Young children will sometimes say something like sugar has 'disappeared' into water when it dissolves. This is taken at face value by some, but it is likely that they simply mean it can no longer be seen. One way of heading off this ambiguity is to use coloured solutes such as raw sugar or jelly crystals so that the continuing presence of the substance is obvious. In this activity you can see that the sugar is still present in the pool of water because of its oily texture and viscosity, obvious when a drop lands on the surface. It also tastes sweet.

**Key idea:** Sugar dissolves gradually in water.

**You will need:**

- an eyedropper
- water
- a sugar cube
- a small dish.

Allow drops of water from an eyedropper to fall on a sugar cube, ten drops at a time.

Use a serial drawing technique to record what happens (draw what has happened after each ten drops).

**Taste the liquid at each stage.**

**Where has the sugar gone?**

**Discuss the difference between dissolving and melting.**

**Explanatory note:** When a substance dissolves in water or another liquid (formally called 'the solvent') it breaks down into its component molecules and disperses completely amongst the water molecules. If children do not have a view of matter being made up of particles they will not have access to this model, but the idea of matter breaking up and dispersing into water can be talked about even with young children. For the middle years, it may be appropriate to role-play the break-up of matter into particles, or to make drawings of the way they might appear in a 'really, really powerful microscope'.

ACTIVITY:  
DISSOLVING  
AND MIXING

**Key idea:** Dissolving is not the same as mixing. With dissolving the solution is clear or translucent. Mixtures are cloudy since the substance is often still in solid form, suspended in the liquid.

**You will need:**

- small quantities of sugar, salt, cornflour, chalk, vegetable oil, starch, talcum powder, candle wax, naphthalene flakes or mothballs
- spoons
- water and jars
- methylated spirits
- small heating pans and a hotplate (or electric frying pan).

**Predict whether the different substances will dissolve in water.**

**Try a small quantity (about a quarter of a teaspoon) of each substance in 50 mL of water. Will meths dissolve any of the substances that did not dissolve in water? Stir and observe for each substance. Record your observations.**

**Note that a solution is always translucent (see-through, but possibly coloured), while a mixture, consisting of undissolved grains, is cloudy.**

**Now predict what will happen if these are gently heated in a pan. Observe and record your results. Which of these were reversible reactions?**

**Explanatory note:** When flour is mixed with water it does not dissolve, but the individual flour particles disperse into the water. A microscope would make this clear, but the visual effect is that the mixture is cloudy rather than clear, or at least translucent, as is the case when substances dissolve.

The effect of heat on dissolving rates, and the amount that will dissolve, is dramatic for some substances. Sugar can be used to explore this. Another factor is the size of the grains. Smaller grained sugar will dissolve quicker because it has more surface area exposed to the water, for the same amount of substance. (Icing sugar does not follow this trend because it contains more than sugar. Read the label!)

ACTIVITY:  
DISSOLVING  
SUGAR IN  
DIFFERENT  
LIQUIDS

**Key idea:** Solids may dissolve in some liquids but not others, depending on molecular factors.

**You will need:**

- sugar
- a teaspoon
- jars with the following liquids: water, vegetable oil, vinegar, lemonade.

**Will sugar dissolve in the different liquids? (Use very small amounts.) Predict, test and record.**

**Explanatory note:** Whether a substance will dissolve in water or other substances (such as alcohol) depends on the molecular properties of the solvent and solute.

ACTIVITY:  
SUGAR  
SOLUBILITY

**Key idea:** This activity is suitable for Year 2 upward.

**You will need:**

- five different types of sugar (e.g. brown, coffee, white, cube, castor, icing, etc.)
- an eyedropper
- five petri dishes
- water
- drinking glasses, beakers or saucers.

**Place a small amount of sugar into a petri dish. Count the number of drops of water it takes to cause the sugar to dissolve.**

**Put the same amount of sugar into the same amount of water in each of five glasses. Time how long each takes to dissolve.**

**What needs to be controlled? Will you stir the water? Is there any difference between using warm or cold water?**

**Is there a link between size of crystal and dissolving speed? Can you generate a reason for such a link?**

**Explanatory note:** All other things being equal, the sugar with the finest grains should dissolve fastest because for the same amount of sugar there is much more surface area for the water to interact with sugar molecules.

ACTIVITY:  
MAKING  
MARMALADE

**Key idea:** Food preparation can involve many types of change to materials.

**You will need:**

- 1 kg fruit (oranges and lemons)
- saucepan and hotplate (or electric frying pan)
- 1 kg sugar
- water
- jars.

**This activity will need to be already set up at the beginning of the session to allow enough time.**



**Cut up 1 kg of fruit (lemons and oranges). Place the fruit and 1 L of water in a saucepan and boil for one hour. Allow to stand for several hours. Reheat. Add 1 kg sugar and simmer. Take samples regularly to test for setting. When the marmalade is ready, place in jars.**

**Throughout the cooking process take test samples and observe the constitution of the mix. Discuss the concepts that are essential in understanding the jam-making process: dissolving, mixing, breaking down cellular structures.**

ACTIVITY:  
MAKING JELLY

**Key ideas:** Jelly involves the dissolving of jelly crystals. The consistency of the jelly depends on the ratio of jelly and water.

**You will need:**

- jelly crystals
- a saucepan or bowl
- a spoon
- a source of hot water (safety precautions are essential)
- jars for jelly
- a fridge.

**Dissolve jelly crystals in hot water to make jelly. Refrigerate until set. Discuss what happens.**

**Compare what happens when you use half, and twice, the recommended amount of water.**

ACTIVITY:  
MAKING  
CRYSTALS

**Teaching note:** Some of the substances that work for making crystals are salt, Epsom salts, sugar, borax, alum (aluminium potassium sulphate), photographer's hypo, baking soda (bicarbonate of soda), laundry soda.

**Key idea:** Dissolved material still exists in the solution. It can be retrieved.

**You will need:**

- a beaker of water
- a heat source to heat the beaker
- a crystal substance
- a small piece of cotton.

**Heat a small beaker of water. When it is boiling, dissolve as much crystal substance as possible in it.**

**Suspend a small piece of cotton with a knot in the end in the solution, and put aside to let cool. Observe the growth of crystals.**

**Discuss what happens.**

**Many ideas for growing crystals can be found by searching the Web for 'crystal growing'.**

ACTIVITY:  
CHROMA-  
TOGRAPHY

**Key idea:** Inks are made from different dyes that have different rates of dissolving in water.

**You will need:**

- **textas**
- **strips or circles of absorbent paper**
- **water in a container (or petri dishes).**

Place dots of texta of various colours in a line across a strip of absorbent paper, about 2 cm from the bottom. Suspend the paper with the bottom in water. You will observe the different water-soluble dyes that make up the pen colours.

As a variation, you could try circles of paper in a petri dish, or you could staple cylinders of paper to stand in a beaker. What interesting patterns can you make?

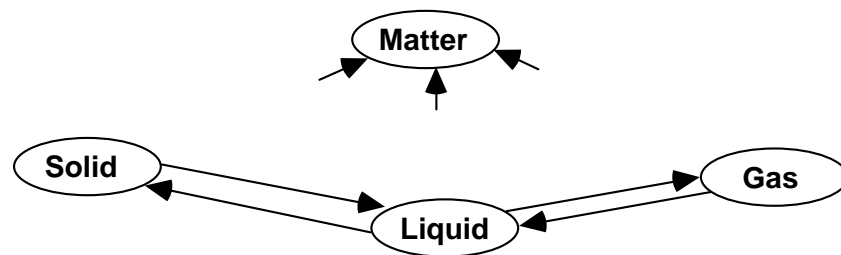
Try food dyes, inks, various biros, pens, etcetera.

Try various solvents such as vinegar or meths.

EXTENSION

Consider the following diagram:

FIGURE:  
CONCEPT MAP:  
STATES OF MATTER



Write appropriate statements that link each concept to each other concept, and back to the most inclusive concept presented: matter.