

IN A STATE



LESSON 1: WHAT ARE MY PROPERTIES?

Key vocabulary:

solid, liquid, hard, soft, pour, flow, pile, pool, surface, horizontal, runny, viscous, transparent, opaque, sticky, grain, powder, force

Resources:

Mini whiteboards and pens; 10–16 sets of: cotton wool, aluminium foil, wood, clear rigid plastic, containers of salt, water, milk, colourless shower gel, ketchup (or materials with similar properties); a range of solids and liquids to include: hard, rigid materials (such as wood, rigid plastic, glass, ceramic, metal, rock), flexible materials (fabric, foil, string, wire), soft and malleable materials (modelling clay, clay, salt dough, tack), sponge, cotton wool, granular and powdery materials (salt, sugar, sand, talcum powder, cornflour, bicarbonate of soda), transparent and opaque materials, liquids of different viscosity (water, milk, shower gel, washing up liquid, handwash, undiluted squash, ketchup, syrup); additional containers for pouring; magnifiers; two large sheets of sticky notes

Health and safety:

Remind children not to taste any of the materials. Do not use any materials which are harmful or irritant (see Be Safe! section 17).

LESSON SUMMARY:

In this lesson children will explore the properties of solids and liquids, demonstrating what they already know. By the end of this lesson they will be able to use key properties to distinguish between solids and liquids.

National curriculum links:

Compare and group materials together according to whether they are solids, liquids or gases

Learning intention:

To classify materials as solids or liquids by observing their properties

Scientific enquiry type:

Grouping and classifying

Working scientifically links:

Identifying differences, similarities or changes related to scientific ideas and processes

Success criteria:

- I can compare materials using their properties.
- I can describe the properties of solids and liquids.
- I can use a material's properties to decide whether it is a solid or a liquid.

EXPLORE:

Organise children into groups of two or three, and give each group the same selection of solids and liquids. Do not, at this stage, share the learning intention. Select three materials from your set and ask the children to make brief observations of their properties, decide which is the odd one out and write the name of this material on their whiteboard. Emphasise that any material could be the odd one out; the purpose of the activity is giving justifications, not finding one 'right' answer. Give children a short time limit then tell children to show their answers. Choose children who have given different answers to justify their choice, e.g. 'I chose ... because ...' Repeat with different combinations of materials. Pay particular attention to whether children describe any of the materials as solid or liquid and whether they are considering properties which characterise solids and liquids, such as defined shape.

Some suggested combinations of materials:

Cotton wool, aluminium foil, wood block: children may focus on shininess, hardness or rigidity but may also use the word solid to describe the wood block, while not recognising that the other materials are also solids.

Milk, colourless shower gel, ketchup: children may focus on colour, transparency or viscosity. They may describe the milk as the odd one because it is the only liquid, not recognising that the others are also liquids.

Clear rigid plastic, water, salt: children may focus on transparency, whether it will pour or flow or recognise that one of the materials is a liquid. They may describe the plastic as the only solid, showing that they do not recognise that salt is also a solid.

At this stage the emphasis is on establishing what the children already know. As the activity progresses focus children's attention on the words solid and liquid, and at the end of the activity establish that all the materials they have been given are either solid or liquid. Discuss the meaning of these terms.

ENQUIRE:

Explain to children that their challenge is to observe a variety of different materials and to use those observations to decide if the material is a solid or a liquid.

Ask: *What other solids and liquids can you think of?* Some children will be able to give a wider range of answers, including less typical examples; their answers may help you to group them for the activity. The challenges are differentiated by the materials provided, which become increasingly more difficult to classify, leading to more refined definitions of a solid and a liquid.

Organise children into groups of three or four and provide each group with a set of materials and magnifiers. Ask them to work as a group to sort the materials into a set of solids and a set of

Key information:

There is a distinction between the properties of the material (which define whether it is solid or liquid) and the properties of the object (which do not necessarily define whether it is a solid or liquid).

Key information:

These children should understand that the fundamental feature of a solid is that it holds its shape, whereas liquids can be poured and will spread out. Some liquids flow so slowly that you cannot actually see them moving. Children should also observe that the surface of a liquid remains horizontal when the container is tipped. Children should be encouraged to use words (such as solid) in their scientific meaning.

Key information:

Encourage children to closely observe the materials such as gravel, sand, salt, flour and talcum powder and recognise that even the powders are made up of individual solid grains which hold their shape and have all the properties of a solid.

Key information:

These children will understand that a solid will hold its shape under normal conditions but that this can be altered when a large enough force is applied to it. Solids such as sponge or cotton wool can apparently be compressed; this is because of the spaces in them. The actual solid material (sponge or cotton) does not change.

liquids. Any materials which they are not sure about or which they think may not fit into either set can be put to one side. They should label their sets using sticky notes and record their work by photographing it then, as a group, make lists of the properties of solids and liquids. The challenges can be presented to the whole class using the Challenge slides.

Encourage children to handle the materials, including squeezing and trying to bend solids, tipping the containers and pouring from one container to another. As children are working ask them questions.

Ask: How did you decide whether this is a solid or a liquid? What is similar about these materials? In what way are these materials different? In which group does this material go? If children have set aside any materials, support them in using their lists to consider which group they might go into.

Challenge 1: Children compile lists of the properties of solids and liquids from statements provided and sort the statements provided

Provide children with a set of materials which are mostly 'typical' solids or liquids. Include a flexible and a soft solid, such as foil and modelling clay, and one with small pieces, such as gravel, but no powders. Choose transparent and opaque liquids which can be seen to flow. Give children a copy of Properties statements (Resource sheet 1).

Children who are able to complete this task can be challenged by being given additional materials from Challenges 2 and 3 to classify.

Challenge 2: Children list the properties of solids and liquids on a writing frame

Provide children with a set of materials which are mostly 'typical' solids or liquids, including a flexible and a soft solid, such as foil and modelling clay, and one with small pieces, such as gravel. In addition provide granular and powdery solids, such as salt and flour and more viscous liquids. Give each group an enlarged copy of Properties of solids and liquids: Challenge 2 (Resource sheet 2).

Challenge 3: Children list the properties of solids and liquids on a writing frame under the headings: All solids ... Some solids ... All liquids ... Some liquids ...

Provide children with a set of materials which are mostly 'typical' solids or liquids, including a flexible and a soft solid, such as foil and modelling clay, and one with small pieces, such as gravel. Include granular and powdery solids, such as salt and flour and more viscous liquids, and provide sponge, cotton wool and a very viscous liquid such as thick hair gel or treacle. Give children a copy of Properties of solids and liquids: Challenge 3 (Resource sheet 3).

REFLECT AND REVIEW:

Choose a few children to each present a material from their group's selection and identify whether it is a solid or liquid.

Ask: How did you decide which group to put it in? Which properties did you use? If any groups have materials they have not been able to classify, discuss these as a class and agree whether they are solid or liquid. Compile a class list of the properties of solids and liquids for reference and display.

EVIDENCE OF LEARNING:

Watch and listen as children group the materials. Listen to the properties they use to describe the materials.

Are children using solid as a synonym for hard, rigid or opaque? Can they successfully sort hard solids and runny liquids? Can they classify soft, malleable, flexible and compressible solids? Can they classify very viscous liquids? Can they classify granular and powdery solids? Can they give reasons for their classifying which correctly identify distinguishing properties of solids and liquids? Can they explain why powders appear to behave like liquids when poured and how their behaviour is different from that of liquids?

IN A STATE



LESSON 2: WHAT HAPPENS TO THE ICE HANDS?

Key vocabulary:

ice, water, melt, observe, measure, fair test, variable, shape, size, temperature

Resources:

Ice hands, trays, measuring equipment such as measuring cylinders, rulers, tape measures, string, weighing scales

Health and safety:

Children should not handle ice directly from the freezer.

Key information:

Children should identify temperature, size and shape as variables that will affect how long the sculptures last.

LESSON SUMMARY:

This is the first part of a two-part lesson. In this lesson children will use ideas from observing melting ice to help them to plan a fair test investigation to answer a question. In Lesson 3 they will carry out their investigation and draw conclusions. By the end of this lesson children will have planned a fair test and will know that melting and freezing are changes of state.

Preparation required:

The ice hands need to be made the day before they are needed. Instructions are provided on Making ice hands (Resource sheet 1). The Explore section of the lesson will need to be started earlier in the day to allow for the observations over time of the melting ice hands.

National curriculum links:

Observe that some materials change state when they are heated or cooled and measure or research the temperature at which this happens in degrees Celsius °C

Learning intention:

To plan a fair test investigation to test ideas about melting ice

Scientific enquiry type:

Observing over time leading to fair testing

Working scientifically links:

Setting up simple practical enquiries, comparative and fair tests

Success criteria:

- I can make careful observations of melting ice.
- I can make predictions based on my observations of melting ice.
- I can plan a fair test to answer a question by:
 - deciding which variable to change
 - deciding which variable to measure and how to measure it
 - deciding which variables to keep the same
 - correctly heading a table to record results

EXPLORE:

Do not discuss the learning intention yet. Put an ice hand in a tray on each table.

Ask: *What material is this? How is it made? What will happen if we leave these hands in the classroom? Why do you think this will happen?*

Tell the children they are going to observe and discuss the ice hands at intervals during the day while they are doing other lessons. They will need to record their observations. Ask children to think, pair share: What observations or measurements could we record? How can we compare how the different groups' ice hands are melting? Suggestions may include drawings, photographs or taking measurements of different parts of the hand. At this stage allow children to try out their own ideas, providing the measuring equipment they suggest. As they continue to observe the hands and discover the limitations of their methods, they may make other suggestions such as measuring the water in the tray or the mass of ice remaining to see which hand has melted the most. As the ice hands are melting confirm that children recognise that the liquid in the tray is water.

At regular intervals, or when something interesting happens such as a finger falling off, make and record observations and compare the ice hands.

Ask: *How has your ice hand changed? Which bits are melting fastest/slowest? Why do you think that is? Are all the ice hands melting in the same way and at the same speed? How do your observations/measurements show this? Can we make different observations or measurements? What do you think will happen next? Why do you think this?*

At the start of the science lesson review the observations children have made. If the ice hands have fully melted compare how long each one took to melt.

ENQUIRE:

Organise children into groups of three or four. Explain that their challenge is to plan an investigation of the effect of different variables on how fast ice melts. Ask them to suggest success

criteria for planning a fair test. Record these, modifying if necessary. Give each group a generic fair test planner. When planning, encourage children to think about how easy and useful it was to make the different observations and measurements of the ice hands earlier.

Each challenge group will investigate a different variable. The challenges are differentiated by the amount of support provided for planning and recording and the complexity of the data collection. As far as possible allow children to select their method of data collection. Ask questions while children are working.

Ask: What is the variable you are changing? What variables will you need to keep the same? How will you do this? What will you measure or observe to collect your results? How will you do this? What resources will you need? What headings will you need on your results table? What do you predict will happen? Which one do you think will melt first/last?

Challenge 1: Children investigate the effect of size on the rate of ice melting

Children should recognise that the blocks should be different sizes but the same shape and should be kept at the same temperature by all being left in the same location. It is not necessary for them to identify the blocks using measured data, only as small, medium, large, very large and so on. They should obtain measured results, such as by recording how many minutes each block takes to melt, by leaving them for the same amount of time and measuring the amount of melt water or changes in dimensions/mass. Some children may make observations, recording by ranking (first to melt, second and so on).

Challenge 2: Children investigate the effect of shape on the rate of ice melting

Children should recognise that the different shaped blocks should be made with the same amount of water and should be kept at the same temperature by all being left in the same location. They should be encouraged to obtain measured results, such as by recording how many minutes each block takes to melt or by leaving them for the same amount of time and measuring the amount of melt water or changes in mass.

Challenge 3: Children investigate the effect of temperature on the rate of ice melting

Children should recognise that the ice blocks will all need to be the same size and shape. They should be encouraged to measure both the independent variable (temperature) and the dependent variable (using one of the methods suggested above). They will need to choose 3 or 4 locations with significantly different and relatively constant temperatures such as a fridge, a cool place (indoors or outside, depending on the season), a warm place and hot place such as by a radiator or a sunny windowsill. The locations should not include a freezer (all temperature measurements should be above zero).

REFLECT AND REVIEW:

Ask each group to peer assess another group's plan against the success criteria. Choose some children to identify two stars (plus points) and a wish (suggested improvements) for the plan they have been reviewing. Return the plans and allow a few minutes to make any improvements.

EVIDENCE OF LEARNING:

Listen to and question children when they are working in groups. Look at their plans.

Can they choose variables to change and measure which will enable them to answer their question? Do they draw on their experience with the ice hands when deciding what to measure and how to do it? Do they know the correct units of measurement? Can they identify which variables need to be kept the same and suggest how they will do this? Can they correctly head a table with the variable to be changed in the first column and the variable to be measured in the second one? Can they recognise whether another group's plan is a fair test which will answer their question?

CROSS-CURRICULAR OPPORTUNITIES:

This lesson could provide a context for meeting the Y4 statement 'interpret and present discrete and continuous data using appropriate graphical methods, including bar charts and time graphs'. In a linked lesson children's own measurements (or secondary data provided for the purpose) of amount of melt water collected at regular intervals could be used to produce and interpret a line graph of change over time.

SNAPSHOT ASSESSMENT: WHICH STATE IS WHICH?

Year group: 4 | Module 1: In a State. Lessons 1, 5, 6, EL3

Curriculum statement:

Compare and group materials together, according to whether they are solids, liquids or gases.

Resources:

5-7 materials, including a hard and soft solid; a powder; 2 liquids of different viscosity; a gas

Activity instructions


This activity is for individual children or pairs of children.
Arrange the headings 'solid', 'liquid' and 'gas' next to each other (or draw a simple table). Ask the child / children to sort the properties cards under the correct headings to show properties that apply to solids, liquids and gases, which allow us to sort materials. Explain to children that if a property applies to more than one state of matter, they can place it so that it overlaps two columns. There may be some statements that do not fit into any of the columns – leave these on one side.
Note: If two children are working together, they must discuss and agree where to place each one.
Now present the children with the materials and ask them to place each under the correct heading, explaining how they know where to put each property card.

Questions to check understanding

Can you explain why you placed this card here? Does this property apply to all [solids / liquids / gases]? Will it help us to decide what state a material is in? What properties are you looking for to help you to sort the materials? What happens when you pour a powder or grainy solid? How can you tell that the powder is a solid? How can you tell that the [viscous liquid] is a liquid?

Curriculum statement is achieved if the child:

Can place the cards in the correct columns.
Can recognise that 'transparent', 'opaque' and 'hard' are not characteristics that are useful for sorting into solid, liquid and gas. Can correctly sort the materials, giving reasons that relate to their properties.



are transparent	have a horizontal (level) surface
spread out to fill all of the space they are in	are opaque
are hard	can be compressed (made smaller)
can be poured	can flow

SNAPSHOT ASSESSMENT: WHICH STATE IS WHICH?

Year group: 4 | Module 1: In a State. Lessons 1, 5, 6, EL3



stay the same shape

change shape
when put into different
containers

make pools

are very light

can spread out

always stay the
same size

make piles

solid

liquid

gas

SNAPSHOT ASSESSMENT: CHANGES OF STATE

Year group: 4 | Module 1: In a State. Lessons 2, 3, 4, 7, 8, 9, 10, EL1, EL2

Curriculum statement:

Observe that some materials change state when they are heated or cooled, and measure or research the temperature at which this happens in degrees Celsius (°C).

Activity instructions

This activity is for individual children or small groups of children. Show the children the images on the pages below. If necessary, clarify what they show without using the words for the state of matter or the change of state. Give the change of state cards to the children and tell them to match the cards and pictures (some cards match with more than one picture).


Choose a picture and ask: *What is the name of the change of state happening here? How can you tell that it is happening? What material is changing? Can you give me a sentence that describes this change of state? Is the change taking place at a cold, warm or hot temperature?* Give children the images of the ice cube, butter, chocolate and glass. Ask: *Which one melts at the lowest temperature? Which needs the highest temperature to melt? Can you put them in order of melting temperature?*

Questions to check understanding

Can you think of any other materials that melt at very high temperatures? Can you think of another material we could safely melt in the classroom? Do you know the temperatures at which water freezes and melts?

Curriculum statement is achieved if the child:

Knows which changes are caused by heating and which by cooling. Can identify which are the changes of state and describe which state the material is changing from and to, and how they can tell that the change is taking place. Can recognise changes of state that involve materials other than water. Can identify which changes are taking place at cold, warm and hot temperatures. Can state the freezing and boiling point of water and identify materials with higher or lower melting or boiling points.



melting	boiling
evaporating	freezing
condensing	solid to liquid
liquid to gas	gas to liquid

SNAPSHOT ASSESSMENT: CHANGES OF STATE

Year group: 4 | Module 1: In a State. Lessons 2, 3, 4, 7, 8, 9, 10, EL1, EL2

