Unit 4D Solids, liquids and how they can be separated

Adapted from QCA Science Unit 4D

ABOUT THE UNIT

In this unit children learn about the differences between solids and liquids and recognise that the same material can exist as both solid and liquid. They identify changes that occur when solids and liquids are mixed and how to separate undissolved solids from a liquid. They learn that melting and dissolving are different and recognise that when a solid dissolves it is still there.

Experimental and investigative work focuses on:

- deciding what apparatus to use
- making and recording observations and measurements
- drawing conclusions.

Work in this unit also offers opportunities for children to explain everyday observations about processes such as dissolving and filtering using scientific ideas.

This unit takes approximately 11 hours.

WHERE THE UNIT FITS IN

Builds on Unit 2D 'Grouping and changing materials', Unit 3C

'Characteristics of materials' and Unit 3D 'Rocks and soils'

Children need:

- to know vocabulary used to describe materials
- to be familiar with melting and freezing
- to know how to separate solids by sieving.

Links with 4C, 5C and 5D.

VOCABULARY

In this unit children will have opportunities to use:

- terms relating to states of matter and to separation *eg solid, liquid, melt, freeze, solidify, dissolve, solution, filter, undissolved, dissolved*
- expressions for making suggestions using 'if', 'might', 'could'
- descriptions using a sequence of ideas.

RESOURCES

- a range of measuring jugs, cups or cylinders
- collection of solids, liquids and powders in transparent containers
- magnets
- water wheel or sand wheel?
- range of sieves, funnels, filters, coffee bags and tea bags
- marbles
- solids which behave differently with water *eg salt, instant coffee, sugar, flour, plaster of Paris, sand, glass, beads, ball bearings, chalk*
- set of cards illustrating everyday processes to match with cards naming scientific processes

EXPECTATIONS

at the end of this unit

most children will:	describe the differences between solids and liquids; describe melting and dissolving and give everyday examples of each; name some materials that will and some that will not dissolve in water; explain why undissolved solids can be separated from a solution by filtering and show how to do this; recognise that although it is not possible to see a dissolved solid it remains in the solution
some children will not have made so much progress and will:	name some solids and liquids; describe that when ice melts it turns to a liquid, that salt or sugar dissolves in water but sand won't and separate an undissolved solid from a liquid by filtering
some children will have progressed further and will also:	state that some materials *eg metals* have to be heated to a very high temperature before they melt and explain that when solids dissolve they break up so small they pass through the holes in the filter paper

LEARNING OBJECTIVES CHILDREN SHOULD LEARN	POSSIBLE TEACHING ACTIVITIES	LEARNING OUTCOMES CHILDREN	POINTS TO NOTE
	Elicit children's existing knowledge of materials by presenting them with a collection of solids and asking them to group these according to their own criteria, recording reasons for their choices. Revise language for describing properties.		Teachers will need to take account of what this introductory work shows about children's knowledge and understanding of materials in their short-term planning for this unit.
• to identify solids and liquids • that there are liquids other than water	♦ Present children with additional items for the collection including liquids of differing viscosity and ask them to divide them into two groups only. If necessary supplement the examples with pictures. ♦ Discuss the groupings with the children introducing the terms 'solid' and 'liquid' and ask children to re-group the items in this way. ♦ Ask children to write down or draw in as many ways as possible how the solids and liquids are different from each other and how they are similar. It may be helpful to ask questions *eg* – *Are all the liquids colourless?* – *What happens to the liquid if you change the container it is in?* – *Can you spill the solids?* – *What happens if you tilt the bottle the liquids are in?* Draw children's attention to particular properties. ♦ Extend the activity by presenting children with some 'difficult' items *eg cotton wool, sponge, sand, rice* and ask them to classify these as solids or liquids.	• correctly classify materials as liquid or solid *eg wood, iron, syrup, shampoo, cooking oil,* explaining the reasons for their choices • describe similarities between solids *eg they don't change shape when you move them* and between liquids *eg they move when you tilt the bottle* and differences between solids and liquids *eg you can pour the liquids but not the solids* • classify items *eg rice, sponge* as solids	Children would not be expected to know the term viscosity, 'runniness' is an adequate description. Materials such as sponge can be classified as solids at this stage although they change shape easily because of the air within them.

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• to make careful observations and measurements of volume recording them in tables and using them to draw conclusions • that liquids do not change in volume when they are poured into a different container	♦ Revise with children how amount/quantity of liquids are measured. (volumes) Let children look at empty liquid containers (e.g. drinks bottles, drinks cans etc.) to see how the amount of liquid is indicated. ♦ Ask children to find out and record in a table what happens to shape and volume when liquids are poured from one container into a different shaped container. Talk with children about what their results show and ask them to use them to make a generalisation.	• measure accurately volumes of liquids and record these and observations of shape in a table • use their results to conclude that although liquids change shape when they are poured into a different container they do not change volume	Large volumes are easier to compare when they need to be poured from one measuring container to another.
• that solids consisting of very small pieces behave like liquids in some ways	♦ Review what was found out about liquids in the previous activity. ♦ Ask children about the ways in which solids are different to liquids. *(Do any of the children mention that powders are different in some ways to other solids?)* ♦ Ask children to explore and describe how powders and solids consisting of many small pieces *eg rice, salt, sand* are different or similar to liquids *eg by tilting jars containing these, by trying to use sand to turn a water wheel, by sieving through gauze.*	• describe similarities between powders and liquids *eg they both can be sieved through gauze, you can use a stream of salt or sand to turn a wheel like a water wheel* • explain that the powders flow like liquids because they have very fine particles	At this stage the word ‘particle’ is used for ‘very small pieces’.

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• that the same material can exist as both solid and liquid • that liquids can be changed to a solid by cooling and this is freezing or solidifying • that a solid can be changed to a liquid by heating and this is melting	♦ Ask children to suggest when they have seen water freezing, and what conditions are necessary for this to happen. ♦ Ask them to suggest how to make ice melt. Elicit examples of other familiar materials melting or solidifying *eg wax running down the side of a candle, chocolate melting etc,* and let children explore what happens to wax if it is held in the hand or put in a warm place. ♦ Ask children how to keep familiar materials *eg ice, chocolate, butter* from melting and help them to relate these to temperature.	• explain how to turn water to ice and ice to water • describe that ice melts when it is left in a room but that some other things have to be warmed to make them melt	Many everyday examples of melting or freezing *eg chocolate melting* are complicated by the other changes that also take place. Consequently melted chocolate does not return to its original state when it is cooled. Children should make the connection with work done in Science Unit 4C (Keeping Warm)
• that different solids melt at different temperatures • that melting and solidifying or freezing are changes that can be reversed and are the reverse of each other	♦ Use secondary sources *eg video, CD-ROM pictures* to illustrate molten metals or molten lava and emphasise that many materials have to be heated before they melt. Ask children to use secondary sources to find out more about melting metals and to record information about why this is important. ♦ Ask children if they can think of any materials that will not melt. Ask about metals. Demonstrate the melting of solder.	• describe what has to be done to turn a metal or lava into a liquid and to turn it back to a solid and suggest reasons for melting metals	Children often confuse melting and dissolving. It is helpful to establish the idea of melting and its connection with an increase in temperature before dissolving is introduced. First-hand observation of a molten metal could be introduced by demonstrating a soldering iron. **SAFETY** – Children should not touch the apparatus and should stand back when it is demonstrated.
• that solids can be mixed and that it is often possible to get the original materials back • to choose appropriate apparatus for separating a mixture of solids	♦ Demonstrate to children how solid particles of different size can be separated by sieving to remind them of earlier work on soils. ♦ Challenge children to separate a mixture of *eg sand, rice, dried peas and paper clips using their own techniques and to explain why these worked.*	• separate the mixture • explain that mixtures can often be separated because the large grains won't go through the holes but the small ones will	

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LEARNING OBJECTIVES CHILDREN SHOULD LEARN	POSSIBLE TEACHING ACTIVITIES	LEARNING OUTCOMES CHILDREN	POINTS TO NOTE
• that changes occur when some solids are added to water • to make careful observations, recording results in tables and make comparisons	♦ Tell children that they will be exploring what happens when a range of materials are mixed with water. ♦ Ask children to predict the different outcomes. ♦ Ask children to explore what happens when a range of materials *eg salt, instant coffee, sugar, flour, powder paint, chalk, sand, glass beads or marbles, plaster of Paris,* are mixed with water. Children are encouraged to make a prediction before testing each material (but not to record their predictions). ♦ Ask children record their results in a table. ♦ Ask children to group the solids according to what happens in the experiment.	• describe different types of behaviour when solids are mixed with water *eg sand and glass beads settle on the bottom, you can't see salt and sugar any more, the plaster of Paris makes a hard solid with the water*	Children often describe dissolving by saying the solid disappears. It is important to discuss this with them and to clarify their meaning. Subsequent work should help them to understand that although the dissolved solids cannot be seen they are still present in the solution. **SAFETY** – Care should be taken that children do not inhale plaster of Paris dust.
• that when solids do not dissolve or react with the water they can be separated by filtering • to choose apparatus to separate an undissolved solid from a liquid	♦ Ask children to suggest and try out how they could get marbles or sand back from the mixture with water. ♦ Discuss with the children why marbles can be separated from water by coarse sieves but sand cannot. ♦ Ask for suggestions of how to modify the apparatus to get sand back possibly illustrating ideas using tea bags or coffee filters. ♦ Children try out apparatus and materials *eg muslin, paper towels, gauze bandage, blotting paper, fabrics* they have suggested and describe and explain what they did.	• explain that the sieves will separate marbles from water but not sand *eg the marbles are too big to go through the holes but the sand is small enough* • explain that filters are like sieves with very small holes which the small pieces of sand and chalk cannot go through	

LEARNING OBJECTIVES CHILDREN SHOULD LEARN	POSSIBLE TEACHING ACTIVITIES	LEARNING OUTCOMES CHILDREN	POINTS TO NOTE
• that some solids dissolve in water to form solutions and that although the solid cannot be seen it is still present • to predict whether salt or sugar can be separated from a solution by filtering and to test the prediction to see if it was correct • to decide what apparatus to use • when it is safe to taste things to test them	♦ Remind children that when salt and sugar are added to water clear solutions are obtained, and if necessary show them this again. ♦ Ask children to say what they think has happened to the salt and sugar, remind them *eg of adding sugar to tea or salt to cooking vegetables* and to suggest how they could find out *eg by tasting the solution.* ♦ Ask children to predict whether the salt or sugar could be separated by filtering. ♦ Discuss what they would need to do to find out whether their prediction is correct and help them to decide how to do this. ♦ Find out by testing whether their prediction is correct or not.	• suggest how to test these predictions *eg mix the salt and water and then pour it through a filter,* if the liquid that comes through tastes salty we didn't separate the salt • explain that sugar or salt can't be seen but are still present *eg I can't see the sugar but it still tastes sweet so it must have gone into the water* • explain why filtering cannot separate dissolved sugars or salt from a solution *eg saying the holes in the filter are big enough for the salt to go through* • explain why it was safe to taste the solution *eg we used clean water and clean beakers and we knew we'd only put salt in*	It is important to clarify that children recognise the difference between melting and dissolving. **SAFETY** – Scrupulous hygiene must be observed for all tasting activities. Ensure all utensils and surfaces are clean. Get children to wash their hands before the activity. Take care sugar and salt do not become contaminated. Buy fresh samples for this activity. Explain that it is only safe to taste or smell things in science when specifically told that it is safe. That even when food materials (including sweets) are used in science lessons, they may not be safe to eat.
	Review work on solids, liquids and separating solids and liquids by presenting children with a series of cards showing everyday processes *eg using a tea bag, adding salt to cooking, warming fat in a pan for cooking vegetables, putting ice cubes in a drink, warming a frosted windscreen, getting lumps out of flour* and cards naming processes *eg filtering, dissolving, melting, sieving* and ask children to match the cards. Talk with children about how they knew how to match the cards.		