SCIENCE OF HEALTHY SKIN

A science investigation pack for teachers of 9-11 year olds

CENTRE for INDUSTRY EDUCATION COLLABORATION

CRODA

Contents

Introduction

This resource is based upon actual processes used in an industry which researches, develops and produces ingredients for a wide variety of applications such as home care, personal products and health care.

Through the sequence of activities, children explore some of the processes involved and challenges faced within the speciality chemical industry. They have opportunities to develop and implement both creative ideas and innovative solutions to scientific and industrial problems.

The activities focus on innovation in science. Innovation is more than just having an idea; it's about finding a way of turning ideas into reality. Being able to innovate is what makes a company successful.

The timings given for each activity are a guide, and will vary from class to class. They range in length from 1 to 3 hours.

ACTIVITIES AND ACCOMPANYING WEBSITE

It is intended that the website http://www.scienceofhealthyskin.org.uk is used to introduce each storyline and that the children interact with the web pages throughout their investigations. For ease of reference the web address is printed at the bottom of each page. In particular, questions, animations and other activities used in the plenary sessions will greatly enhance and embed the learning and also provide the stimulus for further investigation.

The activities are organised into three themes:

Fleece to Grease: Extraction of lanolin from wool grease

Fun with Foam: Development of a bubble bath recipe

Safe in the Sun: Exploration of sunscreen ingredients and products

The investigative activities in each theme provide opportunities for the children to explore the varied roles of scientists in industry in practical ways allowing the development of key skills. The children are introduced to a number of different challenges, each requiring the use of enquiry skills, discussion and problem solving. In some activities, a guided enquiry is used to model a specific process. It is intended that children be encouraged to develop their own ideas and methods of recording. Differentiation may be achieved through discussion techniques, rich questioning, presentation of results, analysis of data and in drawing conclusions.

> *I have not seen much new material for teaching science that has such real application. It is a brilliant resource for Year 6. Once the revision and SATs tests are over, this is an interesting and exciting topic to maintain their science enthusiasm until Year 7.*
>
> *The children had their eyes opened to science in the real world. I really enjoyed teaching it. Really glad I came across it. Thank you! (Year 5 teacher, Northamptonshire)*

ACTIVITY SUMMARY

Theme	Summary of activities
Fleece to Grease	Based upon the extraction of lanolin from wool grease, the activities include testing immiscible liquids using oil and water and investigating the effects of adding detergent to produce emulsions which in turn reduce the efficiency of the separation of oil from water. Products containing lanolin can be manufactured in pastille form. The final activity in this section involves investigating techniques for producing pastilles and testing the effect of viscosity upon the pastilles produced.
Fun with Foam	The children develop a method for producing and measuring foam, whilst learning that formulation scientists choose ingredients because of their specific properties. They go on to mimic methods used by these scientists to make and test their own bubble bath recipe.
Safe in the Sun	The children learn that some materials must be physically changed to enable them to be used as ingredients for applications such as sun care products. They learn that different levels of UV protection can be provided by using different types and amounts of ingredients in sunscreen products and go on to test a series of sunscreen products and rank in order of protection level.

1. Oil and water

1 hour

Based upon the extraction of lanolin from wool grease, the activities include testing immiscible liquids using oil and water and investigating the effects of adding detergent to produce emulsions which in turn reduce the efficiency of the separation of oil from water. Products containing lanolin can be manufactured in pastille form. The final activity in this section involves investigating techniques for producing pastilles and testing the effect of viscosity upon the pastilles produced.

OBJECTIVES

- To demonstrate that mixing is a reversible change
- To explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible
- To observe that detergent can cause immiscible liquids to mix, producing an emulsion
- To take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheet 1
- Role badges (Appendix 1)
- 300 ml water - sample A
- 100 ml sunflower oil - sample B
- 50 ml clear detergent - sample C
- 50 ml water –sample D
- 50 ml water-sample E
- 5 clear plastic mini pop bottles or lidded containers
- Food colouring – 2 colours
- Pipette
- Teaspoon or similar for stirring
- 100 ml measuring cylinder

ADVANCE PREPARATION

One method of organisation is to give children job roles and provide them with corresponding badges. Should the teacher decide to use role badges, a template and explanation for use may be found in Appendix 1.

Add 2-3 drops of food colouring to samples D and E, making each a different colour.

INTRODUCING THE ACTIVITY

Use the website area Fleece to Grease. The story of lanolin is the starting point for this activity. In Fleece to Grease, the children follow the web pages from the shearing of sheep, cleaning of the wool, and extraction of wool grease, to the stage of separation of the lanolin from the soap layers. They learn that in the tank there are two layers of liquids: an upper layer of lanolin with other liquids beneath. The company needs to separate as much lanolin as possible from the liquids. However, the scientists believe that one of the liquids in the tank may be affecting the separation. At this point the teacher introduces the practical activity.

ACTIVITY

This is a guided enquiry activity in which children make predictions, follow instructions and observe changes. It teaches scientific enquiry skills to be used in subsequent investigations in this resource. The children are organised into groups of four and decide upon their roles. Each group is provided with two liquids, water and sunflower oil, labelled A and B, representing the soapy under-layer and the lanolin above. They observe the liquids and, prompted by questions, discuss and predict what they think will happen to the liquids when they add one to the other, invert or shake the container or place it on its side.

The children measure 60 ml of sample A and pour into a container such as a mini pop bottle. 20 ml of sample B are then added and the lid replaced. The volumes may be adjusted to suit the size of the container used, ensuring that the layers of oil and water can be clearly seen. The children explore, observe and discuss the liquids, initially tipping the container on its side, then inverting it, before shaking or stirring it gently for a few seconds and allowing it to stand. The teacher can ask some of the following questions:

Did the liquids mix?

Did shaking make the liquids mix?

Did the shaking time or vigour of shaking affect the mixing?

The teacher then reads an e-mail from a technical manager (Activity sheet 1) explaining that lanolin and water normally do not mix, they need to separate the lanolin but they are experiencing some problems. They think another liquid is affecting the efficiency of the process, and believe it might be one of three samples C-E. The children are to investigate whether adding any of the samples affects the separation of the two liquids.

The children initially should try adding a small volume, e.g. 2 drops of sample C to the water and oil in the container, and observe what happens to the liquids. They should then stir or gently shake the liquids, allow to rest, to observe and consider:

Are the liquids still separate?

If not, do they separate after a time?

How long does this take?

They could try observing the effects of increasing the quantity of sample C before preparing further mixtures of A and B and repeating the test with samples D and E.

PLENARY

The children share their observations and conclusions with the class[1].

Did any of the samples affect the separation of the two liquids?

Did all groups have the same result?

What will they report to the company?

EXTENSION ACTIVITY

The children can try investigating what happens if they increase or decrease the ratios of oil and water used or the volume of the samples added, preparing a fresh sample of oil and water each time. Can they discover whether there is a minimum volume of the test sample required to prevent the liquids separating?

INFORMATION FOR TEACHERS

If oil is poured into water, the oil will float on the surface of the water; the two liquids will not mix. An emulsion is a mixture of two or more such liquids that are usually immiscible (cannot be blended or mixed together). Examples include vinaigrette or milk. Common emulsions are unstable and do not form spontaneously but they can be produced by shaking or stirring. In this activity, shaking or stirring the container of oil and water will produce a dispersion of tiny droplets of oil in the water but these droplets will join together, eventually reverting back to their separate constituents. Emulsifiers, including detergents, are substances that can be added to immiscible mixtures to produce a more stable emulsion. Adding a few drops of detergent to the oil and water before stirring or shaking will disperse the oil droplets throughout the water producing a milky emulsion. The results the children obtain will depend upon the ratios of oil and water, volume of detergent added and the amount of shaking or stirring used. Use two bottles to compare emulsions. Add 0.5 litres of water and 5 ml of oil to each bottle. To one bottle add 0.5 ml of washing up liquid. Shaking the bottles for a couple of minutes will produce emulsions of differing stability. The oil droplets will try to reassemble and resurface in each but the one containing detergent will be a longer lasting emulsion. The foam produced following agitation of the container after the addition of detergent may make it difficult initially to identify the layers of oil and water.

1 If using the roles from Appendix 1, this would be done by the Communications Manager.

AMBASSADOR ROLE

An ambassador could supplement and enhance this activity by showing the children samples of their company's emulsions, surfactants (types of emulsifiers) and immiscible liquids in sealed containers and by giving real examples of when it is necessary to use them in industry. They could also bring photographs showing the laboratory and large-scale equipment used to separate liquids, along with photographs and information/stories about people who work in this area of the business.

e-mail from **Sumptuous Skincare Ltd**
From: Melanie Williams
To: Science Consultants
Subject: Separating liquids

Dear Science Consultants,

I believe your firm knows about the extraction of wool grease from sheep's wool. Here at **Sumptuous Skincare Ltd** we separate 'lanolin' from wool grease. Our operators melt the wool grease, pour it into a tank, add other ingredients and stir the mixture. The liquids are pumped into a second tank and the lanolin floats to the top. Our operators can then pump out the top layer of lanolin, to use in other products.

The company needs to separate as much lanolin as possible from the other liquids. However, we are experiencing a problem. Our scientists believe that one of the ingredients may be affecting the separation.

We have therefore sent you samples of the liquids we believe may be causing the problem. We would like you to observe the effect each of these ingredients has on the separation process.

We would be grateful to receive your observations, conclusions and any advice you may have.

Kind regards

Melanie Williams

Melanie Williams
Technical Manager, **Sumptuous Skincare Ltd**

2. The pastillator

2 hours

Based upon the extraction of lanolin from wool grease, the activities include testing immiscible liquids using oil and water and investigating the effects of adding detergent to produce emulsions which in turn reduce the efficiency of the separation of oil from water. Products containing lanolin can be manufactured in pastille form. The final activity in this section involves investigating techniques for producing pastilles and testing the effect of viscosity upon the pastilles produced.

OBJECTIVES

- To understand that it is important to test ideas using evidence from observation and measurement
- To understand that different liquids have different viscosities
- To discover variables that affect the size or shape of drops (pastilles) produced

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheet 2
- Devices for making drops, e.g. teaspoon, drinking straw, pipette, squeezy bottle from ketchup
- 2-3 liquids of differing viscosities, e.g. sunflower oil, bubble bath, liquid soap

ADVANCE PREPARATION

100 ml of each liquid in containers labelled 'Test liquid 1, 2 or 3'.

INTRODUCING THE ACTIVITY

Use the website area Fleece to Grease - Using Lanolin. The children watch the final stages of the production of lanolin and discover that lanolin can be mixed with other ingredients to make many products. They will see one of the processed lanolin products emerging in the form of pastilles from the pastillator. The lanolin product is runny when it enters the pastillator and falls through a mesh onto the conveyor in the form of drops called pastilles. The pastilles travel along the conveyor, cool, solidify and are bagged to be stored and used as an ingredient in manufacture.

The teacher reads the email on Activity sheet 2 which explains that Sumptuous Skincare Ltd is always seeking to improve the efficiency of its processes. Their scientists think that there may be a way to increase the number and speed of pastille production. They would like the children to investigate techniques for making drops, first using water and then two or three sample liquids, to investigate whether the runniness of liquids affects the quality or size of drops or the time taken for the drops to be made. They should also investigate whether the surface on which the drops land affects the size, shape or number of drops.

ACTIVITY

In their groups, the children discuss their ideas for techniques and equipment needed for making droplets of liquids. They test out their ideas using water and the resources they have suggested. The children are then shown the test liquids, samples 1-3, and asked to create and test their own methods for producing drops and recording their findings. They should be allowed time to observe the liquids before carrying out the activity. Each group could investigate a selection of its own or the following questions, depending upon the ability of the children:

How many ways can you find to make water drops?

Can you find a way to make the drops the same size each time?

Which method is easiest?

Which method would you recommend?

Does your method work as well with the sample liquids?

How can you make your test fair?

Are the drops always the same size/shape?

What happens when you drop the liquid from different heights?

Is it better to make the drops quickly or slowly?

Do the drops always stay the same shape?

How many drops can you make exactly the same size and shape?

Does a runny liquid or thick liquid make better drops?

What is the largest drop you can make?

If you change the surface on which the drops land, do the drops change in size or shape?

PLENARY

Each group reports its findings to the class2. The teacher could collate the class results on the whiteboard, and lead discussions by asking some of the following questions:

Which technique for drop-making proved most effective?

Which method produced drops that could be replicated most easily?

What did they discover about the runniness or viscosity of the liquids and drops produced?

Did runniness affect drop quality or the number or shape of drops?

Was there an ideal runniness for producing drops?

What recommendations would they make to Sumptuous Skincare Ltd?

The children produce a report, poster or presentation containing their measurements, graphs, conclusions and recommendations for Sumptuous Skincare Ltd.

The teacher returns to the web page ‘Lanolin Uses’ in the Fleece to Grease section of the website where the children discover the wide variety of products containing lanolin, such as cosmetics, coatings and health care items.

EXTENSION ACTIVITY

The groups may like to design, make and test a device or system for producing many drops of the same size and shape in the quickest time possible.

AMBASSADOR ROLE

Ambassadors could support this activity by acting as experts, giving their opinion on the effectiveness, quality and originality of the different designs. They could also show the children samples of pastilles from their pastillator, large A3 photographs of parts of the machine in action, photographs of the operators and answer any questions the children may have.

> *I think the lessons are wonderfully explained. The resource list and suggested activities are fantastic and have really taught my children a lot about how to plan an investigation. They understand the nature of a fair test much better and understand what a 'variable' is. The website has also been a useful resource to engage the children and we have loved the idea of working with a local company.*
> *(Year 6 teacher, N Yorks)*

e-mail from **Sumptuous Skincare Ltd**
From: Melanie Williams
To: Science Consultants
Subject: The Pastillator

Dear Science Consultants,

You have seen on the website how we make lanolin from sheep wool grease. Lanolin can be mixed with other ingredients to make lots of other products. You saw one of our lanolin products on a machine called a pastillator. The lanolin product is runny when it enters the pastillator and falls through holes onto a conveyor in the form of drops called pastilles. The pastilles travel along the conveyor, cool, go solid and then are put into bags.

Sumptuous Skincare Ltd is always trying to improve the efficiency of its processes. Our scientists think that there may be a way to increase the number of pastilles produced and how quickly they are made.

They would like you to help them in their experiments.

1. Would you investigate some different ways of making drops, using sample liquids instead of the real ingredients as the ingredients we use are expensive? Our customers like the pastilles to all be the same size, so you should try to make your drops the same size too if you can.
2. Would you also investigate whether the runniness of the liquids affects the quality or size of drops or how quickly the drops can be made?
3. Finally, they would like to know whether the surface the liquids are dropped onto affects the size or shape of the drops.

Would you record your evidence and report your results to our scientists? We look forward to hearing from you.

Melanie Williams

Melanie Williams

Technical Manager, Sumptuous Skincare Ltd

3. Making foam

1.5 hours

Children develop a method for producing and measuring foam, whilst learning that formulation scientists choose ingredients because of their specific properties. They go on to mimic methods used by these scientists to make and test their own bubble bath recipe.

OBJECTIVES

- To plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary
- To report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheets 3-5
- Bowl
- 2 litre pop bottle
- 20 ml Creamy foam bath Pipette/syringe
- 100 ml measuring cylinder Drinking straw
- Spoon
- Whisk
- Bucket of water (for rinsing between tests)

INTRODUCING THE ACTIVITY

Use the website area Fun with Foam - A Frothy Question The online activity provides the starting point for this lesson. The children are asked if they can define foam, describe where they see it, and when it might be useful. The children discuss ideas, first with a thinking partner, and then with their group. The teacher gathers ideas from the groups. Returning to the web page, images of foaming products, such as soap or shaving foam are displayed. The children are asked to take the Foam Challenge, by finding different ways of making and measuring foam.[1]

1 If accessing the internet is not possible, the teacher may use Activity sheets 3-5 to introduce and support challenges 3-6 to the children. A demonstration by the teacher of foaming, using shaving foam or soap, could also enhance this lesson.

ACTIVITY

The teacher explains that the children are to first devise a method for producing and measuring foam using a standard measure of soap to water (e.g. 1 ml creamy foam bath to 300 ml water). Each group is to discuss and test ideas for making foam, which may include blowing through a straw, stirring, whisking, beating or shaking. They decide what to measure and how to record their results. A pipette or syringe could be used to add the soap to water. One method the children may try is to mark graduations of 100 ml up the side of a 2 litre pop bottle. The bath foam and 300 ml of water are added, the lid tightened and the bottle shaken vigorously. Ten shakes produces fairly reproducible foam although other methods also work. The children decide which method is most effective at producing foam and which can be replicated to produce similar volumes of foam each time.

According to their ability, the children could extend their investigation to discover whether there is a link between the volume of water used and the amount of foam produced.

PLENARY

The groups share their results with the class. One way of doing this is to ask a member of each group to be the envoy, answering questions and explaining their method to the other groups. An explanation of envoying and other discussion techniques may be found in Appendix 2.

A class set of results, such as a bar chart showing method versus volume of foam, could be collected and displayed on the whiteboard. Groups investigating volume of water used and amount of foam produced may record their data in the form of line graphs providing further opportunities for analysis of data and drawing conclusions.

Returning to the website, the children have the opportunity to interact with the website by inserting their methods of making and measuring foam, and consider:

Which methods were most successful and why?

How did they measure the amount of foam?

Could they repeat their results?

AMBASSADOR ROLE

The ambassador may initiate these activities and act as an advisor/consultant if present for the practical sessions. The ambassador may also play the part of a judge and provide detailed information for the latter stages of the activities, such as marketing aspects. Ambassadors could also explain the difficulties encountered on the plant by excessive foam production, leading to blockage in pipelines or affecting movement of product or ingredients from one vessel to another. They could explain the measures taken by engineers to overcome these problems.

> *Perfect for Year 5. Very good ideas to draw children in; all enjoyed and gave very positive feedback. The resource notes are very thorough and ensured that each step was easy to carry out. The resource is creative and uses literacy and other core subjects to engage the children. It is appealing to many types of learner.*
> *(Year 5 teacher, Widness)*

e-mail from **Sumptuous Skincare Ltd**
From: Mike.Smith@SumptuousSkincareLtd.co.uk
To: Science Consultants
Subject: Foaming

Dear Consultants,

We are a big company that makes ingredients for lots of every day products such as sun creams, soap, medicines and food. Our scientists are developing a new bubble bath and would value your advice on suitable ingredients and recipes.

The bubble bath must produce the right amount of foam, must not be too runny, must be kind to the skin and should look and smell nice to appeal to our customers.

We have sent you a sample of our latest bubble bath to test. We would like you to find a method to discover how well our sample compares with bubble bath from the supermarket. Our scientists need to know whether you think it produces enough foam and whether the foam lasts long enough.

Secondly, the bubble bath must not be too runny. We would appreciate you testing some ingredients that we could use to make the product thick enough for our customers.

Finally, the bubble bath should moisturise the skin and feel creamy.

We would like you to develop and test your own bubble bath recipe using the information you have from your experiments.

Please send us your recipes and any measurements, tables, graphs and other evidence that you think would help our scientists to produce a quality product for our customers.

We look forward to hearing from you.

Mike Smith

Mike Smith
Scientist, Sumptuous Skincare Ltd

e-mail from **Sumptuous Skincare Ltd**
From: Mike.Smith@SumptuousSkincareLtd.co.uk
To: Science Consultants
Subject: Foaming

Dear Consultants,

Thank you for the information you sent to us about all your investigations. Your ideas for making foam were very interesting and creative. Our formulation scientists here at Sumptuous Skincare Ltd were very impressed with the accuracy of the measurements in your foam tests.

We were interested to know that in Activity 4 you discovered the test sample of our new bubble bath did not seem to perform very well compared with other well known brands. Our Quality Control scientists believe that we must have added too much oil to our recipe. Oil is essential to provide moisture and to prevent the other ingredients irritating the skin. However, too much oil can reduce the amount of foam that the bubble making ingredient can produce.

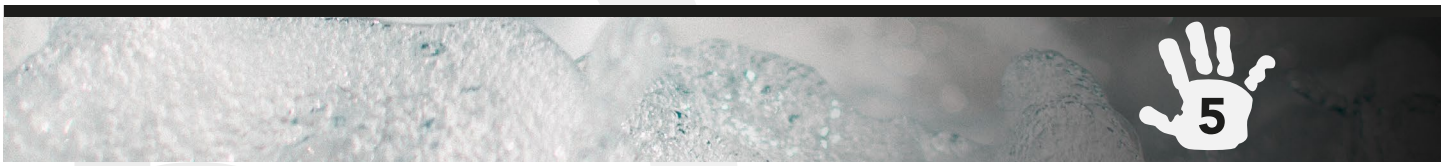
We have sent you a copy of the recipe we used in our test sample (Activity sheet 5). We would like you to develop an improved bubble bath recipe of your own, using these ingredients and the information you have from previous experiments. We would particularly like to know how changing the amount of thickening granules and oil affects the quality of the product. Once you have tested the foaming of the bubble bath and you are happy with the improved recipe, our scientists would be grateful to receive the recipe and any measurements, results, photographs or other evidence you may have.

Yours sincerely

Mike Smith

Mike Smith
Scientist, Sumptuous Skincare Ltd

Activity Sheet 5



Simple Foaming Bubble Bath

Ingredient	Function	Volume (ml)
Bubble making ingredient	Foaming ingredient	54.5
Essential oil	Moisturising/Anti-irritancy	45.0
Thix	Thickener	0.5
Fragrance	Fragrance	As required
Colour	Colourant	As required

Slowly add Thix to Foamer solution until thickened. Then add Essential oil slowly with gentle stirring.

Add fragrance and colour as required.

Appearance: Opaque

Viscosity: Not measured

4. Comparing bath foams

1.5 hours

Children develop a method for producing and measuring foam, whilst learning that formulation scientists choose ingredients because of their specific properties. They go on to mimic methods used by these scientists to make and test their own bubble bath recipe.

OBJECTIVES

- To plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary
- To take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate
- To report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations

RESOURCES

(Per group of 4 children unless otherwise stated)

- 1-3 creamy bath foams (e.g. supermarket & branded) Sumptuous Skincare Ltd 'test product'
- Pipette
- 2 litre pop bottle marked in 100 ml
- 100 ml transparent tubes or measuring cylinders Stop clock

ADVANCE PREPARATION

In a plastic bottle labelled 'A' or 'test product', add 50 ml of clear shower gel (e.g. Simple shower gel) to 50 ml sunflower oil and mix gently to minimise air bubbles and foaming.

INTRODUCING THE ACTIVITY

Use the website area *Fun with Foam - Comparison Test*. This web page introduces the next activity. Scientists at Sumptuous Skincare Ltd have sent the children a sample of their new bubble bath. They would like the children to use a method of foam production to test the sample and one or more known brands of creamy bath foam. They should compare the quality of foam by considering the amount of foam produced and how long it lasts. They are to report their results to the company.

ACTIVITY

Using the method of foam production previously researched, the children choose the measurements to take and the method of recording their results, e.g. photographs or a table. A typical result adding 1 ml creamy foam bath to 300 ml water using the 'shake in a bottle' method is shown in the table below:

Sample	Foam Height Achieved[1] after 10 shakes
Supermarket Creamy Bath foam	550 ml
Test Product (Simple shower gel with sunflower oil)	390 ml

Measuring cylinders or seal-able plastic tubes may be substituted for pop bottles. In this case, the volume of water would need to be adjusted to suit the container, but the same 'shake' method is effective. Typical results using a supermarket 'basic' range creamy foam bath are shown below:

Foam bath (ml)	Water (ml)	Foam height (ml)	Volume of foam (ml)
0.5	20	70	50
0.5	30	80	50
0.5	40	90	50
1	20	80	60
1	30	95	65
1	40	100	60
Foam bath plus oil			
1	20	50	30
1	40	75	35

The children should be encouraged to display the data collected in the most appropriate way. Measuring the amount of foam against time the foam lasts would enable a line graph to be produced and the more able could be challenged to make predictions using extrapolation.

1 This includes the layer of water. The children may choose to measure the foam only.

PLENARY

The children are asked to describe the method they used for measuring the foam, and the following questions may be posed:

What do the results show?

Were there any unusual measurements?

Did the groups draw similar conclusions?

Would you recommend the test recipe?

What advice would you give to the company scientists?

Returning to the website area Comparison test, the children are invited to respond to the company by considering whether their tests were fair and which sample produced a good, long-lasting foam.

INFORMATION FOR TEACHERS

The addition of oil reduces the foaming ability of the product and hence the shower gel with oil should foam less. By adding oil, such as sunflower oil, to a clear liquid, the appearance will change from clear to opaque/creamy. It is compared to a creamy foam bath in order to make the two test products look similar.

AMBASSADOR ROLE

An ambassador may be present during the investigations and provide industrial support for the activities, acting as an advisor/consultant. They may assist in the planning and help with problem solving. They could also bring samples of a variety of anti-foaming agents used in industry, such as oils or powders, or photographs of the effects of adding such agents.

5. Increasing viscosity

1.5 hours

Children develop a method for producing and measuring foam, whilst learning that formulation scientists choose ingredients because of their specific properties. They go on to mimic methods used by these scientists to make and test their own bubble bath recipe.

OBJECTIVES

- To test the effectiveness of a selection of thickening agents to increase viscosity of liquids
- To take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate

RESOURCES

(Per group of 4 children unless otherwise stated)

- Resources per group of four children 300 ml clear shower gel
- Cup of corn flour
- Cup of salt
- Cup of hair gel
- Teaspoon
- 100 ml measuring cylinder Blu-tack
- Filter funnel
- Laminated card
- Tidy tray
- Timer
- 3 disposable cups

ADVANCE PREPARATION

Mix the shower gel with 200 ml water to produce a thin clear gel solution. Label this 'bubble-making ingredient'.

Label the cornflour, salt and hair gel, 'powder', 'granules' and 'gel' respectively.

INTRODUCING THE ACTIVITY

Use the website area Fun with Foam - A Runny Problem. This web page introduces the children to the concept of viscosity. The children are asked to consider how they could measure how thick or runny a liquid is. After time for discussion and sharing of ideas, by returning to the web page, the children learn that Sumptuous Skincare's scientists need to produce a bubble bath of a specific thickness, and their current key ingredient is too runny. The company has provided 500 ml per group of this ingredient for the children to use in their investigations. They have also sent some additional items that might thicken the bubble-making ingredient.

ACTIVITY

The teacher should make each group aware that the 500 ml of bubble-making ingredient is provided for all their tests.

The groups plan and carry out their investigations, incorporating the principles of fair testing. They need to consider (i) amount of bubble-making ingredient to use each time, (ii) amounts of thickener to add, and whether to add this gradually, and (iii) how to measure the thickness of the liquid.

Ideas for measuring the viscosity include timing:

1. the fall of a marble or similar through a measuring cylinder of the sample
2. the flow of the sample through a funnel
3. 'blobs' of the sample moving down a tipped surface (tray, laminated card etc.)

They also consider the appearance, feel[1] and end use of the product.

Children should be encouraged to find ways of recording their results independently and in a variety of ways such as tables, graphs, posters, diagrams or photographs.

PLENARY

Each team shares its conclusions with the class using 'snowballing', 'envoying' or 'jig-sawing', as described in Appendix 2. Alternatively, each group in turn could demonstrate its most effective method to the class. The webpage area In the thick of it offers an opportunity for reinforcing the children's conclusions from the investigation.

INFORMATION FOR TEACHERS

The salt will cause an increase in viscosity and will result in a clear, viscous, gel-like mixture. Flour will give an opaque sticky viscous liquid and hair gel will not produce much thickening until large quantities are added. The addition of too much salt will cause a drop in viscosity so this should be added very slowly in small quantities (pinches) with gentle stirring.

1 Teachers should ensure that precautions are taken to prevent allergic reactions to products used. Children could wear protective gloves. Consult ASE's 'BeSafe! ' for guidance.

6. Developing a bubble bath recipe

2-3 hours

Children develop a method for producing and measuring foam, whilst learning that formulation scientists choose ingredients because of their specific properties. They go on to mimic methods used by these scientists to make and test their own bubble bath recipe.

OBJECTIVES

- To compare and group together everyday materials on the basis of their properties
- To give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials
- To model methods used by scientists to make and test their own bubble bath recipe

RESOURCES

(Per group of 4 children unless otherwise stated)

- Creamy bath foam (e.g. supermarket brand) 150 ml clear shower gel
- Cup of corn flour
- Cup of salt
- Cup of hair gel
- Food colouring
- Pipette or syringe
- 5ml fragranced oil (e.g. Body Shop or similar) 50 ml sunflower oil
- Measuring cylinder Teaspoon

ADVANCE PREPARATION

Mix 150 ml clear shower gel with 100 ml water to produce a thin clear gel solution. This is to be the 'bubble making ingredient' in the bubble bath. Thickeners should be labelled as in previous activity. Label the sunflower oil as 'moisturising oil'.

INTRODUCING THE ACTIVITY

Use the website area *Fun with Foam - A Recipe for Success*. The email on this page explains that the scientists at Sumptuous Skincare Ltd are working hard on their recipe for bubble bath and they would like the children's help. The teacher shows the children a commercially available bubble bath which is thick, has a creamy appearance and is coloured and fragranced. The company scientists have asked the children to use the ingredients provided to design a bubble bath that will have similar qualities and will appeal to their customers. They should use the information they have discovered from their other investigations to help them.

ACTIVITY

The children are supplied with all the ingredients. The teacher should explain that the moisturising oil helps to soften the skin and helps to prevent it becoming too dry. They should recall from the results of previous experiments that salt will give the best thickening performance maintaining a clear mixture but only if added in small amounts. They will discover that adding vegetable oil will give a creamy appearance; the colour and fragrance produce the other more aesthetic properties. They should be able to justify their choice of ingredient type and quantity, based on previous findings. They may also test the foaming of their own formulations and use the data to produce a marketing sheet. It may be useful for the groups to plan and explain to the teacher the method they will use before proceeding.

PLENARY

The Communications Manager from each group describes their recipes to the class. Recipes are compared and similarities and differences discussed. Returning to the website, the children are encouraged to design and make a poster to inform customers about the quality of their bubble bath. The web page area Marketing the Mixture provides ideas to support the children in this process.

Each group produces a marketing sheet displaying the key features of the particular formulation. Recipes could be tested by other classes or groups and compared with the claims made on the marketing posters.

EXTENSION ACTIVITY

An e-mail sent to the children after the experiments (Activity sheet 4), together with a sample formulation recipe from Sumptuous Skincare Ltd (Activity sheet 5) giving details of the ingredients used in the test sample, explains that too much oil may have been added. The children are asked to do further investigations to improve the sample recipe by reducing the volume of oil used, eventually producing their ideal bubble bath.

INFORMATION FOR TEACHERS

Ingredients when mixed using a recipe or 'formula' produce a 'formulation'. Some of these ingredients may give the formulation specific properties, producing effects which cannot be made by ingredients when they are used singly. The explanation for adding oil (i.e. sunflower oil) to the formulations is that this can reduce the irritation sometimes caused by other ingredients (foaming ingredients) and it also moisturises and softens the skin. In this case, it also gives the formulation a creamy appearance. It should be apparent at this stage that the addition of too much oil is detrimental to the foaming properties of the recipe.

AMBASSADOR ROLE

Ambassadors from industry could participate in the development of the bubble bath, providing support as an advisor or consultant. They may be able to supply a selection of fragrances for the children to use. If marketing leaflets are designed, these could be presented to the ambassador for feedback and a discussion around the claims and formulation can take place. The presentations and marketing sheets could also be taken away by the ambassador and judged. The ambassador could bring marketing materials in various stages of development, to demonstrate and discuss the processes involved.

7. Lumps or powder?

1.5 hours

Children learn that some materials must be physically changed to enable them to be used as ingredients for applications such as sun care products. They learn that different levels of UV protection can be provided by using different types and amounts of ingredients in sunscreen products and go on to test a series of sunscreen products and rank in order of protection level.

OBJECTIVES

- To demonstrate that mixing is a reversible change
- To compare and group together everyday materials on the basis of their properties
- To take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate

RESOURCES

(Per group of 4 children unless otherwise stated)

- Role badges (Appendix 1)
- Stop clock or stopwatch
- 4 small transparent pop bottles or cups
- Teaspoon of: sugar cubes, granulated sugar, caster sugar, icing sugar 300 ml vegetable oil or sunflower oil
- 2 teaspoons
- 100 ml measuring cylinder

INTRODUCING THE ACTIVITY

Use the website area Safe in the sun - Sun Protection. This web page provides the starting point and background for the activities in this theme. A video clip of the industrial scientist in A Lumpy Problem is used to introduce Activity 7. The teacher then summarises the problem. The main ingredient for sunscreen comes from the manufacturer in the form of big white lumps of solid material, which need to be changed into a powder. The teacher asks the children why they think this is and takes feedback from the class. The teacher explains that, as the real ingredient is very expensive, they will be testing, in cooking oil, solids which mimic those used in industry. In their groups, the children predict which of the samples is best suited to be mixed into a liquid sunscreen. The children are encouraged to explain the reason for their prediction by responding to questions such as:

Which properties of your chosen solid make it better for mixing into the liquid?

In sunscreens, why do we need to make sure the solids/powders are well mixed in the liquid?

ACTIVITY

The children decide upon roles and responsibilities for the investigation (Appendix 1). They add each sugar sample in turn to separate measured volumes of oil and gently shake or stir for 20 seconds; they start the stopwatch and when they believe the majority of the sugar has sunk to the bottom of the plastic container, the stopwatch is stopped and the time noted. They decide an appropriate way in which to record their results.

It is likely that, in most cases, a timed result will only be possible for granulated and caster sugar. Icing sugar is likely to partially suspend in the oil, demonstrating that this would be the best form of solid to use for mixing into oil. Sugar cubes sink quickly to the bottom of the pot preventing accurate timing. For a readable measurement, taller containers could be used, the sugar cubes slightly broken down, or the time taken

for the cubes to drop without any stirring could be measured. Sample results, using 1 teaspoon of each sugar and 75 ml oil each time, are shown below. The table shows the time taken for different sugars to sink in oil (using an 8 cm tall pot).

Sugar Used	Time taken
Time taken	1 min 50 secs
Caster	2 min 35 secs
Cubes	Too quick to measure
Icing	Sugar left in suspension

PLENARY

Teacher and children then discuss the results from the class activity:

Which materials mixed best in the liquid?

Are there any unusual results?

Did the groups obtain similar results?

Which of the samples would the children recommend for the sunscreen and why?

The third screen of the website area A Lumpy Problem shows the children a selection of solids in liquid and provides an opportunity for the children to compare their results with those demonstrated in the animation on screen.

AMBASSADOR ROLE

An ambassador from a local company could act as an initiator to the activity, by introducing the challenge to the children and showing them a sample of ungrounded ingredient. The ambassador could outline his or her job and explain the skills required to carry out the role, explaining that scientists in industry often have to find solutions to problems. Finally, the ambassador could discuss the children's results in the plenary session and ask for their recommendations.

BACKGROUND INFORMATION

The classroom activities are based upon processes in which some materials are changed to make them more suitable for applications such as sun care products. The activities focus upon two main areas: Research and development science, involving the break-up of clumps of particles, and 'applications and claims' science, introducing the concepts of formulating products and testing how well they perform.

Industry produces ingredients called metal oxides for use in a number of applications, and particularly in sun care products such as lotions, sprays and sticks.

When the metal oxide is made, it needs to be filtered from water. After filtration, it is a white 'cake', still containing a lot of water. When the cake is dried it forms large solid clumps. These clumps need to be ground into a powder to (i) stop the solids from sinking to the bottom of a bottle of sunscreen and (ii) give an optimum amount of protection against UVA and UVB radiation.

8. Grinding solids

2-3 hours

Children learn that some materials must be physically changed to enable them to be used as ingredients for applications such as sun care products. They learn that different levels of UV protection can be provided by using different types and amounts of ingredients in sunscreen products and go on to test a series of sunscreen products and rank in order of protection level.

OBJECTIVES

- Compare and group together everyday materials on the basis of their properties
- To plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary

RESOURCES

(Per group of 4 children unless otherwise stated)

- 3 containers with lids
- Cup of one of:
- 1-2 cm pieces of chalk sticks or sugar cubes
- Range of spherical grinding materials, hard and soft and of different sizes e.g. 2 materials from each of the following:
- Hard: Marbles, ball bearings, large beads.
- Soft: Polystyrene balls, Smarties, Cheese ball crisps
- Filter funnel
- 10 - 25 ml measuring cylinder
- Digital weighing scales (0-3 Kg)

INTRODUCING THE ACTIVITY

Use the website area *Safe in the sun - A Lumpy Solution*. The teacher reminds the children of the video clip of the industrial scientist in which he explains that the sunscreen ingredient must be changed from lumps into powder. In groups the class discusses ideas for a suitable method. The teacher explains that in industry, large amounts of the ingredient are needed, so the method used has to be efficient. Returning to the website area, A Lumpy Solution, the children watch the video clip of the industrial scientist suggesting that shaking the lumpy sunscreen ingredient with another material may help to change the lumps into powder more efficiently. They would like the children to try out this idea, and report their results to the company.

ACTIVITY

The teacher explains that as the real ingredient used in sunscreen is very expensive, the industrial scientists have provided other materials (chalk or sugar cubes) for the children to use for their investigation. They have also suggested a selection of grinding materials to use in the shake tests: marbles, beads, ball bearings, polystyrene balls, Smarties, cheese ball crisps.

The groups are given time to examine the samples and to discuss the properties of the materials. Each group chooses an ingredient and a grinding material and explains the reasons for its choice of type, quantity and size of material. The children should plan how they will ensure a fair test. They may consider controlling factors such as number of shakes, time or method of shaking. They must also decide how they will measure the amount of ground ingredient produced.

When each 'shaking test' is completed, the children separate the grinding material from the ingredient, remove any ungrounded ingredient, collect the ground ingredient and measure and record its weight or volume. To measure volume, the ground ingredient could be poured through a funnel into a measuring cylinder. Results may be recorded in a table, bar chart, line graph or other appropriate format.

Sample results with a variety of grinding materials and ingredients each shaken 200 times are shown on page 29.

PLENARY

The children discuss their findings and must decide which grinding 'system' is most effective, taking into consideration the number of pieces and size of the grinding material used. The teacher encourages suggestions as to why some methods were not as effective as others. They could be encouraged to discuss the relative 'hardness' of the materials concerned. Harder materials are better to use for this grinding technique. Grinding material which is too large or too small will work less effectively. They could use photographic evidence to provide a record of their results, displaying samples of the materials used in their investigation. The children decide on an appropriate way of reporting their findings to Sumptuous Skincare Ltd. Returning to the website area, A Lumpy Solution, the teacher can show the children photographs of the milling machine used in industry together with the final product.

AMBASSADOR ROLE

Ambassadors could explain to the children the methods used in industry to grind materials. They could enhance the lessons by bringing photographs of equipment and examples of the actual material being ground, before and after grinding, and the grinding materials such as the ceramic beads used in the plant and laboratory. Samples of titanium dioxide dispersions can be used for demonstration purposes, along with raw, unprocessed materials. In addition to these raw materials, sunscreen formulations in different formats may be used for demonstration. The ambassadors could respond to questions from the children, or give feedback on the quality of the class investigation methods and results.

INFORMATION FOR TEACHERS

Chalk and coffee beans give the largest measurable difference between no grinding material and grinding material being present. Chalk and sugar cubes give the most separable ground product from non-ground material, and also can be closely related to the white titanium dioxide powder used in industry.

Smarties and Cheese ball crisps are good materials to use to demonstrate brittleness of certain solids. We need the grinding material to be durable, and not break apart itself. Upon shaking the Smarties with the chalk/sugar cubes/coffee beans, the shell of the Smarties will break off, along with some of the core material inside the Smarties. With the cheese ball crisps, both materials will break apart, rendering the powdered chalk/sugar/beans unusable.

In industry, after filtering, drying and grinding the dried 'cake' of sunscreen ingredient into a powder, the metal oxide particles are still clumped together or 'aggregated'. The powder is mixed with a cosmetic oil (or water) and a 'dispersant'. In order to break apart the clumps of particles, the mixture passes through a 'bead mill' containing lots of tiny, hard ceramic beads. This is the process being modelled in this activity.

Metal oxide ingredients can also be used in plastics to prevent the degradation of food and drink from UV radiation.

Sample results with a variety of grinding materials and ingredients each shaken 200 times.

Material being ground	Number of pieces used	Grinding material	Number of grinding items used	Volume of ground materials obtained (ml)
Chalk	6	No grinding material	-	0-1
Chalk	6	Medium marbles	8	4-5
Chalk	6	Large beads	6	0.5
Sugar cubes	6	No grinding material	-	3.5-4
Sugar cubes	10	Medium marbles	20	4
Sugar cubes	6	Large beads	6	1
Sugar cubes	6	Small glass beads	20-30	3
Sugar cubes	6	Smarties	10	-
Sugar cubes	6	Cheese ball crisps	6	-
Coffee beans	-	No grinding material	-	0
Coffee beans	8	Medium marbles	10	15

> *I have just done this activity with a small group of 6-8 year olds. They loved the science. We have done some real high level thinking. The children worked out that you need to test and the consequences of not doing. So as well as investigative skills they have really developed their thinking. The children loved the UV beads and a year 2 stood in front of the whole school and asked if anyone knew what SPF means. So plenty of real life learning!*
> *(Year 5 teacher, Lancashire)*

9. Testing sunscreen products

1 hour

Children learn that some materials must be physically changed to enable them to be used as ingredients for applications such as sun care products. They learn that different levels of UV protection can be provided by using different types and amounts of ingredients in sunscreen products and go on to test a series of sunscreen products and rank in order of protection level.

OBJECTIVES

- To compare and group together everyday materials on the basis of their properties
- To explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible
- To record data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs

RESOURCES

(Per group of 4 children unless otherwise stated)

- Bag of UV-active beads[1]
- Small samples (e.g. 5 ml) of factor 5, 15, and 50+ sunscreen Paper towels
- Tidy tray or shoe box
- 3 plastic cups
- Tea spoon
- Pipette or syringe
- Paintbrush
- 10 ml measuring cylinder

ADVANCE PREPARATION

Decant the sunscreens into three containers, e.g. yoghurt pots, labelled A, B, C

1 Bags containing 100-500 beads, that produce one colour or a variety of colours on exposure to UV light, may be ordered online from several suppliers.

INTRODUCING THE ACTIVITY

Use the website area Safe in the Sun - Sunscreen Test. The teacher introduces the lesson by asking the children what they know about sun protection factors (SPFs) and the importance of sun protection. The children could produce a KWL grid (what they know, would like to know and have learned) which they could complete after their investigations. The teacher explains that some exposure to sun is good for us but too much can cause premature ageing, wrinkling, burning and reddening of the skin.

The teacher reminds the children of their previous investigations and that industry makes ingredients that are used in sunscreens. Once the ingredient has been ground into powder and mixed into the liquid, industrial scientists must test the mixtures to see how effective they are. A high SPF sunscreen is good at stopping sun damage to the skin. Low SPF sunscreens also stop sun damage, but are less effective at doing so. The email on the Sunscreen Test website area introduces the activity to the children. The scientists have sent them three samples of sunscreen (A, B, C) and they would like the children to test them to see which one gives the best sun protection. Since we should not use our own skin for these tests, the industrial scientists has also sent some very special beads that change colour in UV light (sunlight).

ACTIVITY

The children discuss how they might test the sunscreens. They must decide how they might apply the sunscreen to the beads and how they can make sure their test is fair. They may decide to measure the same amount of sunscreen each time using spoons, pipettes, syringes or small measuring cylinders. They could use a brush or a spray to coat the beads or apply the sunscreen by putting a measured amount in their hands and rubbing the beads. The activity should be carried out away from external windows if possible, until the beads are to be taken outdoors. This will minimise any colour changes in the first stage of the experiment. Each set of beads could be placed in a tray or box, should be kept covered until taken outdoors and then exposed to the light for a short time. The children then observe the colour change, place the beads in order of protection afforded by the sunscreen and record their results. They predict which SPF they think matches each sample of sunscreen, by closely observing the degree of colour change produced in each case.

PLENARY

Returning to the second screen in the Sunscreen Test area, the children choose which sunscreen gives the greatest protection. The results from the class activity are then discussed:

Did all groups record similar results?

Which sample do they think had the highest SPF? Why?

How did they ensure that they carried out a fair test?

How would they improve their test?

How did their test result compare with that in the animation?

QUALITY CONTROL

The subsequent web pages in this section introduce quality control and allow the children to 'test' samples of sunscreen and interpret results displayed in the form of a graph. The children can also learn about the uses of UV protection for various products.

AMBASSADOR ROLE

Ambassadors could enhance and support the classroom activities by providing UV reactive beads, photographs of sunscreen tests from the laboratory, together with simple tables and/ or graphs of actual results. The children might also wish to report the results of their investigation to the ambassador and ask questions.

BACKGROUND INFORMATION

Some companies which make active ingredients for sun care products do not sell sunscreens directly to consumers. However, companies have 'Formulation and Claims Testing' departments, in which they prepare sunscreen products to test that they perform as effectively as they should. These formulations are tested for their Sun Protection Factor (SPF) and protection against UVA radiation, amongst other properties.

UV active beads change colour in sunlight because they are made from a special reversible photochromic material. This material changes its chemical structure when exposed to ultraviolet light (like sunlight), allowing it to absorb a coloured pigment or dye. Once out of the sunlight it becomes colourless again.

Appendix 1

Role Badges

All of the classroom sessions involve children working together in groups of four.

Each child is responsible for a different job or role within the group and wears a badge to identify this. The images below may be photocopied onto card and made into badges, by slipping them in to plastic badge sleeves. Keep sets of badges in 'group' wallets, to be used on a regular basis in your other science lessons.

Children should be encouraged to swap badges in subsequent lessons; this will enable every child to experience the responsibilities of each role.

Administrator keeps a written and pictorial record for the group

Resource Manager collects, sets up and returns all equipment used by the group

Communications Officer collects the group's ideas and reports back to the rest of the class.

Health and Safety Manager takes responsibility for the safety of the group, making sure everyone is working sensibly with the equipment.

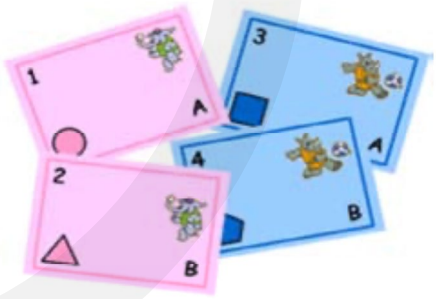
Where groups of 5 are necessary, the following role can be used:

Personnel Manager takes responsibility for resolving disputes within the group and ensuring the team works cooperatively

Appendix 2

Discussion strategies

The following strategies are used extensively as part of the Discussions in Primary Science (DiPS)[1] project, and have been proven to be successful when developing children's independent thinking and discussion skills.



Talk cards

Talk cards support the teacher in facilitating these discussions, with the letters, numbers, pictures and shapes enabling the teacher to group children in a variety of ways.

The example provided here shows one set for use with four children. The set is copied onto a different colour of card and talk groups are formed by children joining with others who have the same coloured card.

Children can then pair up by finding a partner with the same animal or a different letter eg. elephant, rhino or a + b pair. Each TALK pair would then have a card with a different number or shape.

The numbers or shapes may then similarly be used to form alternative groupings and pairings.

Note: The example talk cards are provided in MS Word format so you may make changes if you wish.

ITT (Individual Think Time)

Each child is given time to think about the task individually before moving into paired or group work.

Talk Partners

Each child has a partner with whom she/he can share ideas and express opinions or plan. This increases confidence and is particularly useful where children have had little experience of talk in groups.

A > B Talk

Children take turns to speak in their pair in a more structured way, e.g. A speaks while B listens B then responds. B then speaks to A while A listens and then A responds to B.

Snowballing

Pupils first talk in pairs to develop initial ideas. Pairs double up to fours to build on ideas. Fours double up to tell another group about their group's ideas.

1 For more information go to www.azteachscience.co.uk

Envoying

Once the group have completed the task, individuals from each group are elected as 'envoys', moving on to a new group in order to summarise and explain their group's ideas.

Jigsawing

Assign different numbers, signs or symbols to each child in a group. Reform groups with similar signs, symbols or numbers, e.g. all reds, all 3s, all rabbits and so on. Assign each group with a different task or investigation. Reassemble (jigsaw) the original groups so that each one contains someone who has knowledge from one of the tasks. Discuss to share and collate outcomes.

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The unit was funded by CRODA UK.

First Published 2012

Revised 2021

ISBN 978-1-85342-598-2

Editor – Joy Parvin

Design by Abdullah and Design Solutions.