Safe in the Sun

A science investigation pack

for teachers of 9-11 year olds

Introduction

Context

The classroom activities in this theme are based upon industrial processes in which some materials are changed to make them more suitable for applications such as sun care products.

Activities and accompanying website

The children learn that some materials must be changed to make them more suitable for applications such as sunscreen.

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 place in order of protection level.

It is intended that the website http://www.ciec.org/healthyskin is used to introduce the storyline and that the children interact with the web pages throughout their investigations. In particular, questions, animations, multiple choice and other activities used in the plenary sessions will greatly enhance and embed the learning and also provide the stimulus for further investigation.

Approximate duration

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

National Curriculum links

The investigative activities provide opportunities for the children to explore the varied roles of scientists in industry in practical ways involving 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, consistent with National Curriculum requirements. It is intended that children be encouraged to develop their own ideas and methods of recording and presenting their results and conclusions.

The themes cover substantial areas of Scientific Enquiry (Sc1) and Materials and their properties (Sc3) in the current National Curriculum for Science, many aspects of Using and applying number (Ma 2),.Using and applying measures (Ma 3) and Handling data (Ma 4) in the current National Curriculum for Maths. There are ample opportunities for ‘speaking and listening’ through discussion promoted in the activities. The theme encourages ICT via interaction with the website and through the preparation of presentations to share results of investigations.

Ambassador role

Ambassadors could enhance this theme by introducing or supporting the class investigations and explaining to the children the methods used in industry. Providing photographs of equipment and materials used, bringing actual samples, responding to questions from the children, or giving feedback on the quality of the class investigation methods and results would enrich the activities.

Activity 7: Lumps or powder?

Objectives

- To recognise that some materials need to be changed physically by grinding to make them more suitable for applications such as sun care products.
- To predict and test the time taken by a selection of solids to sink in oil.
- To compare everyday materials on the basis of their material properties.
- To make systematic observations and measurements and use these observations and measurements to draw conclusions.

Resources

Per group of four 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

The interactive page 'Sun Protection' from the Sun-Safe section of the website provides the starting point and background for the activities in this theme. A video clip of the industrial scientist (http://www.ciec.org.uk/healthyskin/A Lumpy Problem) is used to introduce activity 7. The teacher 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 very quickly to the bottom of the pot, potentially being unreadable. For a readable measurement, taller containers could be used, the sugar cubes slightly broken down, or measuring the time taken for the cubes to drop without any stirring'. Sample results, using 1 teaspoon of sugars 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
Granulated	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 website page '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

Ambassadors could explain to the children the methods used in industry. Showing the children photographs of equipment and materials used and bringing actual samples would enhance the activity. An introductory or summary presentation may be given by the teacher about the importance of sun care and sun protection. This will highlight the need for SPF filters and will give importance to the work being conducted by the pupils. The challenge could be set at this stage providing an initiator role for the ambassador.

Background information

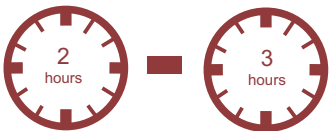
The classroom activities are based upon processes in which some materials are changed to make them more suitable for applications such as sun care products. The activities focus upon two main areas: Research and development science, involving the break-up of clumps of particles, and Applications and 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.

Activity 8: Grinding solids



Objectives

- To recognise that the hardness and size of some solids makes them suitable for certain applications such as grinding.
- To find an effective method to grind solids into a powdered form.
- To compare everyday materials on the basis of their material properties.

Resources

Per group of four children unless otherwise stated

3 containers with lids

Cup of one of: 1-2 cm pieces of chalk sticks, sugar cubes or coffee beans

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

Weighing scales

Introducing the activity

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. The class discuss, initially in groups, 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, '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, sugar cubes or coffee beans) for the children to use for their investigation. They have also sent 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 be encouraged to 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 unground 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 or other appropriate format.

Sample results with a variety of grinding materials and ingredients each shaken 200 times are shown in Appendix 3.

Plenary

The children discuss their findings and must decide which grinding 'system' is most effective, taking into consideration the number and size of the grinding material used. The teacher encourages suggestions as to why some methods were not as effective as others. 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, the teacher can show the children photographs of the milling machine used in industry together with the final product.

Ambassador role

Ambassadors from industry could enhance the lessons by bringing 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 actual titanium dioxide dispersions can be used for demonstration purposes, along with raw, unprocessed materials used. In addition to these raw materials, actual 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 we are trying to mimic in this activity.

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

Activity 9: Testing sunscreen products

Objectives

- To understand that different levels of UV protection can be provided by using different types and amounts of ingredients in sunscreen products.
- To test a series of sunscreen products and place in order of sun protection.
- To understand that some changes are reversible.
- To make a fair test comparison.

Resources

Per group of four children unless otherwise stated

Bag of UV-active beads[5]

Small samples(eg 5 ml) of factor 5, 15, and 50+ sunscreen

Paper towels

Tray or box

3 plastic cups

Tea spoon

Pipette

Paintbrush

10 ml measuring cylinder

Advance preparation

Decant the sunscreens into three containers labelled A, B, C

Introducing the activity

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 **k**now, **w**ould like to know and have **l**earned) which they could complete after their investigations. The teacher explains that some 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 sunscreen has a high SPF if it 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 page 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).

[5] Preferably all the same colour when irradiated (search online for suppliers). Bags containg 100-250 beads may be ordered.

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, pipette, 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

On returning to the second webpage of Sunscreen Test, the children can take part in a short interaction choosing 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?

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 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 respond to 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.

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 own 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.

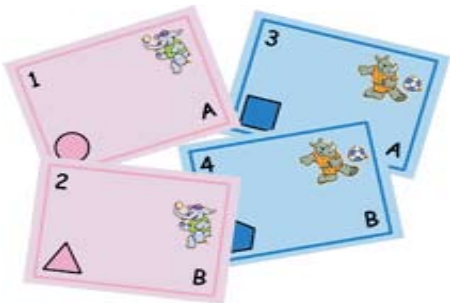
Health and Safety Manager takes responsibility for the safety of the group, making sure everyone is working sensibly with the equipment

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.

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.

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

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.

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.

Appendix 3

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