

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)

”