Jeremy Thomas, Abingdon Science Partnership Coordinator
Holly Irving, Science Coordinator, Caldecott Primary School
March 2020

Crystal Creations Investigation Lesson Plan

Resources Needed:

Table salt (sodium chloride NaCl)
(Range of different salts if available e.g. sea salt and others)
Water
Kettle - see safety note in method section below
Large, heat resistant jug for making solution
Clean, clear containers such as jars (or screw top bottles for taking home from school) (2 per child or group)
Thread or string
Lolly sticks or pencils
Filter paper if available, coffee filters or porous cloth e.g. J-cloth
Thermometers if available

Printing/copying:

Class set of the pupil planning and recording sheets if required
Class set of the Science at Home sheets (for homework) if required

SAFETY

Crystals form best from a saturated solution which requires dissolving as much salt as possible into BOILING water.

It is recommended that the supervising teacher or adult prepares the saturated solution in a large, heat resistant vessel such as a Pyrex jug and then dispenses it to the children once it has cooled to a temperature which is safe to the touch.

Ensure that children are kept at a safe distance where spillage of boiling water from a kettle or during preparation of the saturated solution cannot reach them.

Children should not taste or eat salt or salt solution.

School staff should adhere to their school's risk assessment policy when carrying out this activity.

Jeremy Thomas, Abingdon Science Partnership Coordinator
Holly Irving, Science Coordinator, Caldecott Primary School
March 2020

Starter:
Display photographs from the Presentation Document to discuss ideas about what crystals are and how can we make them?

Activities - Methods for making crystals (read the safety warning on the first page):

1. Prepare a saturated solution in a suitable, large, heat resistant vessel, such as a kitchen jug by adding salt to boiling water (see the safety advice above)
2. Keep adding salt and stirring it into the water until no more will dissolve
3. When no more salt will dissolve, any visible salt left in the liquid will need to be removed by filtering. If laboratory filter paper is not available, then coffee filters or even a J-cloth or similar, porous cloth can be used if clean
4. Dispense the cooled saturated solution to pupils in individual containers - these could be jam jars or cut off plastic bottles. Screw top bottles can be used if the children are to take solutions home
5. The next step depends on how quickly you want crystals to grow and how much you involve the children in designing their own investigations. Options for you to choose from are as follows, in order of time required for crystals to start forming:
    a. Soak a piece of card in the saturated solution and leave it somewhere to dry out
    b. Pour a small amount of solution into a wide dish or saucer
    c. Leave the solution in the original containers and allow crystals to form around the sides
    d. Suspend a piece of thread into the solution from a pencil or stick across the mouth of the container
6. Encourage pupils to choose variables such as
    - Type of salt (if available)
    - Type of container to use - flat, wide, tall
    - Quantity of solution to place in the container
    - Best location for evaporation to happen quickly or slowly
7. More creative or challenging options are:
    a. FOR YOUNGER CHILDREN Suspend shaped pipe cleaners or similar into the solution (see photo below)
    b. FOR OLDER CHILDREN Use small, seed crystals from one of the above methods to challenge them to grow the largest possible crystal. Tips:
        - All containers must be clean and free of any undissolved salt - filter the solution if necessary
        - Place a piece of thread into saturated solution in a dish and evaporate more quickly, in a warm, sunny place to form small, seed crystals on the thread - this is easier than trying to tie the thread around a small crystal
        - Suspend the thread from a pencil or stick into a COOLED, saturated solution so the seed crystals don't dissolve
        - Place the container in a cool, shady, undisturbed place and let the solution evaporate as slowly as possible

Jeremy Thomas, Abingdon Science Partnership Coordinator
Holly Irving, Science Coordinator, Caldecott Primary School
March 2020

Useful sources of information and photos of techniques:

https://sciencenotes.org/grow-table-salt-or-sodium-chloride-crystals/
https://sites.google.com/a/britishschoolmanila.org/growing-crystals/renzo-s-process-paper-1
https://lemonlimeadventures.com/salt-crystal-ornaments-christmas-science-experiment/

Outcomes:

All pupils should be able to:

- Discuss results using verbal discussion, recorded measurements or observations- why was one method better than another? What could be changed to make larger/better crystals?
- Use words accurately in the correct context such as:
    - 'Dissolve/dissolved/dissolving' as a physical change in soluble substances which break up into constituent atoms or molecules (particles) when placed into certain liquids (solvents like water)
    - Evaporate/evaporation as the slow change of liquid to gas as particles escape from the surface of the liquid (boiling is the change of the entire liquid to gas at its boiling point)
    - Crystallisation as the formation of a solid with a particular geometric shape as a liquid solution cools and evaporates

Challenge and next steps:

- Write a report or design a wall poster to display your findings - what method worked well for making the best/largest crystals?
- Modify the method, research ways of growing crystals such as using small, seed crystals first to grow larger crystals from
- Plan and carry out an investigation to find out if different types of salt (if available) grow different sorts of crystals - design a fair test
- Carry out a project on crystals - find out where they are found in nature, what they tell us about rocks and minerals, how they are used in industries, jewellery etc

Jeremy Thomas, Abingdon Science Partnership Coordinator
Holly Irving, Science Coordinator, Caldecott Primary School
March 2020

Suggested homework or follow up projects (see also the Science at Home handouts and print these out if required):

Older children:	***Younger children:***
Display these two leaflets explaining how to mix Oral Rehydration Solution for children in disaster zones or disease outbreaks: http://www.rehydrate.org/ors/pdf/ort-treat-at-home.pdf https://www.cdc.gov/cholera/pdf/posters/11_229310-J_ORS_print.pdf Prepare by discussing and comparing these leaflets, e.g.: Do both leaflets have the same information and all the same instructions? Do you think a parent could follow these instructions? What problems might there be if there was a natural disaster and you weren't in your kitchen or house? Now design an instruction and information leaflet yourself, show it to your parents and ask them if they would be able to use it in an emergency or if they have ideas to improve it.	Ask your parents to help you find a few different ingredients in your kitchen and test whether they dissolve or not. Try things like sugar, salt, coffee, pepper, flour, chocolate powder, baking soda Make a chart to show which ones dissolve and which ones don't. More challenge - for the things that dissolve, can you dissolve the same amount of each one in the same amount of water e.g. one small cup - remember to keep the amount of water the same, measure the amount of each things, maybe with a spoon or a medicine cup, and stir them in the same way for the same amount of time. Make a chart to show your results.

Jeremy Thomas, Abingdon Science Partnership Coordinator
Holly Irving, Science Coordinator, Caldecott Primary School
March 2020

Support Information for Teachers

Real world applications - there are several topics of interest covered by this investigation so here are some real world applications of each one, dissolving, evaporation and crystallisation:

DISSOLVING is an important type of physical change used in many applications from industry to cooking. A physical change is one that can be reversed, unlike a chemical change where a new substance is formed. For instance:

- **Salt can be dissolved in water but if the water is evaporated, the salt will reform as a solid - it has not disappeared, it has just changed its physical form**
- **If you burn cakes during cooking, this is a chemical change - you can't uncook the ingredients and start again, you have new chemicals (probably a lot of carbon compounds!).**

Knowing how fast tablets dissolve is important in drug delivery for pharmacists and doctors - scientists develop different coatings and different mixtures of soluble materials to control the rate at which the actual drug is released (https://www.youtube.com/watch?v=b3J7hdXUhsY)

Dissolving waste paper and packaging is an important area of research to help with waste disposal and environmental impacts (https://www.smartsolve.com/#industries-overview)

Making sugar solutions for food and drinks is a major application in food production and different products might need different concentrations of solution (https://www.chefsteps.com/activities/simple-syrup; https://www.adue.it/oursolutions/sugar-dissolving/)

EVAPORATION is used in salt extraction, concentrating solutions in industry and cooking and as method of separating mixtures e.g. salts from water

Methods for extracting salt from sea water have been important for millennia as salt is an important food preservative and those that controlled salt supply became very rich and powerful in historical times. There are great opportunities for cross-curricular links here - this is just an extract from this fascinating website about the history of salt with many facts and useful illustrations:

The expression "not worth his salt" stems from the practice of trading slaves for salt in ancient Greece. Special salt rations given to early Roman soldiers were known as "salarium argentum," the forerunner of the English word "salary." References to salt can be found in languages around the globe, particularly regarding salt used for food. From the Latin "sal," for example, come such other derived words as "sauce" and "sausage." Salt was an important trading commodity carried by explorers.
https://seasalt.com/history-of-salt

This site has diagrams and information about modern methods of salt production: https://eusalt.com/salt-production

Jeremy Thomas, Abingdon Science Partnership Coordinator
Holly Irving, Science Coordinator, Caldecott Primary School
March 2020

CRYSTALS - growing crystals is a fun activity with good links to learning scientific techniques and enquiry skills, but does it have any real world applications? The answer is yes - crystal growing has important, industrial and commercial applications and knowledge of how crystals grow is useful in fields such as geology and mineralogy.

This activity, growing sugar crystals on a stick, may be controversial but it is one way of making sweets. It's up to you whether you want to mention it to children or let them try it out!
https://www.learning4kids.net/2015/01/07/make-sugar-crystals-stick/

Here is some fascinating information on six different crystal states of chocolate! This could be desirable or not, depending on what you want to happen - sometimes it is understanding how NOT to make crystals that is important!
https://www.scienceofcooking.com/chocolate/why-is-chocolate-tempered.htm

There are amazing and relatively recent applications of crystal growing in industry that you may want to mention to children during discussion. This is a technical article on growing single crystal turbine blades for jet engines - this makes them less prone to failure as pure crystals do not contain the same weaknesses as components made by traditional methods - the blade really is just one, big crystal grown in a mold to produce the required shape:
https://www.theengineer.co.uk/rolls-royce-single-crystal-turbine-blade/
And here is a short video about single crystals if you want to find out more
https://www.youtube.com/watch?v=2xjhK2aSV1E

Crystals in geology - rock types can be identified from the crystals they contain and formation mechanisms identified from the size of the crystals e.g. slow or fast cooling of volcanic rocks leads to large or small crystals. Crystals are usually minerals and may be used in jewellery or mined for metals and useful chemicals. Here are some useful links:
https://www.youtube.com/watch?v=7RwrDYII2Hw
http://www.bbc.co.uk/earth/story/20150623-ten-crystals-with-magic-powers
https://geology.com/minerals/crystal-habit/

Here are some beautiful videos of crystallisation experiments - they may give ideas for techniques to improve crystal growing techniques but are NOT safe without training and proper lab facilities due to the chemicals and apparatus required:
https://www.youtube.com/watch?v=j-MqPHbLotE

Here is some information on growing large crystals from the Royal Society of Chemistry education team:
https://edu.rsc.org/resources/the-art-of-crystallisation-a-global-experiment/1379.article
And more detailed CPD for teachers from Royal Society of Chemistry
https://edu.rsc.org/cpd/evaporation-filtration-and-crystallisation/3009017.article