



Growing Crystals

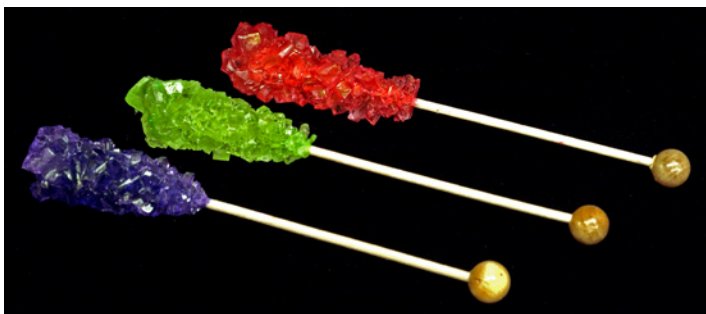
By Kim Sowder and Nelson R. Shaffer

Crystals are the natural, regular form that a chemical compound takes as determined by its molecular composition. The more time a crystal grows under the right conditions, the larger it tends to become. Rock candy is one example of growing large crystals in the natural shape of molecules.

Sugar, also known as sucrose, is composed of 12 carbon atoms, 22 hydrogen atoms, and 11 oxygen atoms ($C_{12}H_{22}O_{11}$). Look at sugar under a microscope; the cubelike shapes are the natural arrangement of the molecules in crystal form. Dry sugar is in a stable state, that is, the crystals will not grow larger. The natural tendency in crystal formation is to create many small crystals instead of fewer large crystals, unless conditions are just right.

When you add sugar to water and heat it, the sugar crystals dissolve into solution. You cannot keep adding sugar in unlimited amounts to a fixed amount of water; at some point, the water will no longer hold the sugar in solution. At that point, the solution is said to be saturated. Heat increases the saturation point, so by heating the water as you add sugar, you are increasing the amount of sugar the water can hold before reaching saturation.

To make rock candy, you create a saturated solution of sugar and water and control the conditions of crystal formation as the solution cools. Cooling the solution causes the sugar molecules to precipitate out. If you provide a "seed crystal," the sugar molecules will grow around it, forming a few large crystals. Follow the recipe and watch how the crystals form. (Children should NOT perform this experiment without adult assistance and supervision. The cooking process involves heat and the sugar solution can be very dangerous to handle until it cools.)



Rock Candy Recipe – *You will need:*

- 4 cups sugar
- 2 cups water
- small saucepan
- candy thermometer
- wooden spoon
- clean glass jars
- popsicle sticks or bamboo kabob skewers
- waxed paper
- 2 rubber bands per jar

Preparation:

Measure the popsicle sticks or skewers inside the jars; the stick should not touch the bottom of the jar when suspended in the solution. Wrap a rubber band around the top end of the stick to adjust its length.

Soak the sticks or skewers in water (below the rubber band) and roll in sugar. Allow to dry completely. If possible, hang them to dry so sugar completely coats the sticks. This provides seed crystals for your crystals to grow on.

Making the solution:

1. Heat water in saucepan over medium-high heat until boiling.
2. Add sugar gradually; stir as you add so sugar dissolves completely.
3. When solution begins to boil, check temperature with candy thermometer; the solution should reach 250 degrees Fahrenheit. At this point, the solution should be slightly thickened.
4. Remove solution from heat and allow to cool to 125 degrees.
5. Carefully pour the solution into the jars. Cover with waxed paper and rubber band the outside rim to hold waxed paper in place.
6. Gently push the end of the stick through the waxed paper and let the rubber banded end rest on top of the waxed paper. Poke a few holes in the waxed paper to help with evaporation.
7. Let the jar sit at room temperature undisturbed for 7 days. Watch each day to see how your crystals grow!

Variations:

You can add food coloring or flavoring to your sugar solution. As in nature, crystals are colored by chemicals that are added to the solution. Beautiful crystals of emerald, rose quartz, amethyst, sapphire, and diamond are some examples.

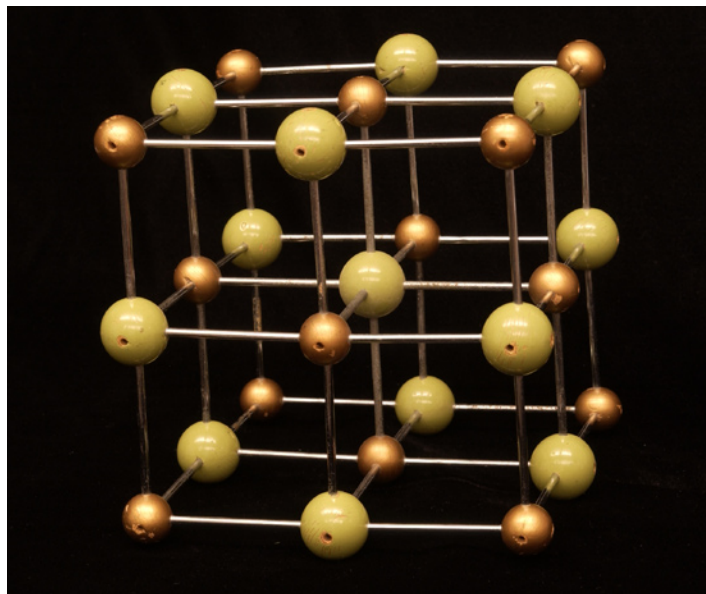
String can be substituted for the sticks in the recipe. The string must be soaked in the sugar solution and hang dried for several days for crystal formation to occur.

Other variations on this experiment substitute table salt or epsom salts for sugar. Of course, you can't eat the epsom salt crystals! The crystals that form are different for each compound. Table salt is halite, or sodium chloride (NaCl). The crystals of halite are cubic in shape. Dissolve 1/2 cup of salt in 1 cup of hot water. Pour into a shallow dish and set aside, undisturbed, for several days.

Epsom salts are magnesium sulfate ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$). Dissolve 1/2 cup of epsom salts in 1 cup of hot water. Pour over a small, flat sponge in a shallow dish. Set aside. The crystals will grow on the sponge. Be sure to observe the shape of the crystals before and after the experiment.

How quickly the solution evaporates can also vary your results. Try setting your jars or dishes in sunlight or near a heat source to speed up evaporation. Keep at least one jar or dish away from sunlight and heat and compare the size of the crystals.

A good reference book on growing crystals is from the Science Study Series, "Order in Nature" book series; the title is Crystals and Crystal Growing by Alan Holden and Phylis Singer (Doubleday, 1960).



This model shows the atomic structure of halite (NaCl).



Salt in three forms. The large crystal in the middle is also salt, or halite, in its natural crystalline shape. The cluster of halite crystals on the right shows how they appear in nature.