Science Weekly 1995

**Crystals**

**Teaching Notes**

**Background**

Scientifically, a crystal can be defined as a solid substance whose **molecules** are arranged in a regular, orderly, repeating pattern. These orderly patterns account for the many scientific and technology ways in which we use crystals today. This definition, though, doesn’t capture the breath-taking beauty, sparkle, and glow which crystals are admired for the world over. Though crystals of gemstone-quality, like diamonds and rubies, are rare, small crystals are a common form of matter. From the frost on a winter’s windowpane to the tiny crystals of sugar we put in our morning coffee, crystals are all around us.

Crystals occur in a variety of fascinating shapes, like spikes, stars, flowers, miniature boxes, pyramids, and more. The six-sided beauty of a snowflake and the smooth plates of an amethyst also reflect the *inner* order of their molecules. The tightly interlocked molecular pattern of carbon in diamonds, makes the diamond the hardest natural substance in the universe. Yet, a differently molecular arrangement of carbon in the point of a pencil allows the carbon to slide off easily as we write on paper.

A crystal forms, or **grows**, by adding the same number of molecules to all its sides in the identical pattern as earlier ones. This is the reason that the sides (or faces) of crystals get larger, but are able to keep the same shape. Some crystals form as molten rock cools and solidifies. Others grow as water evaporates around dissolved solids. Rocks are conglomerations of many small crystals. Each crystal is made of only one chemical substance, but a rock may contain crystals of many kinds. Molecules in volcanic rock or a water solution move around constantly at high rates of speed, bouncing off other molecules many millions of times each second. Under those conditions, it seems remarkable that any could ever line up in the orderly patterns needed to create crystals. Under the right conditions, however, crystals as large as the Hope Diamond do develop.

In 1912, the German physicist, **Max von Laue**, discovered a way in which crystals could provide an even clearer window into the world of molecular structure. Von Laue discovered that passing an x-ray beam through a crystal’s orderly **lattice** of molecules would produce a pattern of spots (something like a shadow) that conveyed very precise information about the shape of the crystal’s molecules. Today, scientists use this method, called **x-ray crystallography**, to discover the shapes of complicated molecules, like the proteins in human cells.

Crystals possess many interesting properties. The way in which some crystals interact with light and electricity make them very valuable in electronic devices, like computers. Other crystals start an electrical current flowing when they are squeezed or stretched. This phenomenon is called **piezoelectricity.** The quartz crystal vibrates so regularly and at such a constant rate, it has become an important part in watches and other electronic equipment. In fact, until atomic clocks were developed, the quartz crystal clock was the standard for scientific time-keeping.

Many crystals can be found in caves where underground rivers flow. In some caves, rainwater has dripped down from above and worn away at soft rocks. When the water evaporated, crystal formations were left behind. Often these crystals are in the form of stalactites (icicle-like formations hanging from the cave ceiling, made of many tiny mineral crystals) and stalagmites (cone-like formations rising form the cave floor). Molten lava also leaves behind deposits of crystals as it cools. Most gemstones, such as diamonds and rubies, are mined from caves and tunnels carved by ancient volcanoes. Recently the Cave of the Glowing Skulls was discovered in a rain forest in Honduras. Scientists believe these sparkling skulls date back to 1000 B.C. to a previously unknown civilization. The skulls are covered with calcite crystals which not only glitter, but have protected the skulls from deterioration over all this time.

Scientists are constantly looking for new ways to grow larger and more flawless crystals, since there are so many scientific and technological uses for crystals today. One successfully, though very expensive method, is to grow crystals aboard the Space Shuttle. Space-grown crystals are especially useful in computers because of their purity. The formation of large perfect crystals requires the precise and intricate alignment of vast numbers of molecules. Even the force of gravity greatly hampers this process. The lower gravity in space allows more perfect and purer crystals to be grown than could be formed on Earth.

**GROWING CRYSTALS – For ALL Levels**

Your students will have an opportunity to grow crystals at all levels. Magnifying glasses will work well for viewing these crystals. ***For best viewing***, however, we recommend using a magnifier of 5x or greater power. A printer’s or jeweler’s loupe is especially well suited for crystal-viewing. Try to obtain one of these to use with your **students** for this topic.

For all ***crystal growing*** activities, we recommend using disposable **dark-colored** plastic plates divided into 3 sections. As an alternative, you can use 3 separate small, dark plastic plates, or plastic plates with black construction paper cut to fit them.

For best results, their crystal solutions should be allowed to evaporate **slowly** and should ***not* be disturbed!** Try to grow the crystals in as warm and humid a place as possible. Set bowls of water nearby to increase the humidity, if needed.

**INITIATING QUESTIONS AND ACTIVITIES (Levels Pre-A-B)**

1. Ask your students if they have ever caught any snowflakes on their sleeves. What did they look lie?
2. Ask if they have ever looked through a magnifying glass before. Have them look through a magnifier at some classroom objects. Ask them to **describe** how looking at an object through a magnifier is different from looking at it with just their eyes.
3. Display some real crystals and geodes. Bring in some of the beautifully photographed books on crystals and gems, so your students can actually see the beauty, shapes, and variety of crystals.

**LEVEL Pre-A**

**Main Concepts:** Crystals are all around us. Many are small. Snowflakes, salt, sugar, and gems are all types of crystals.

**Picture Activity:** Ask your students what they see in the picture on the front page (a big snowflake, frosty patterns on a window, sugar, salt, and a jewel ring). Explain that these are all types of **crystals**.

Ask what WHY-FLY is doing. He is using his magnifying glass to look at very small crystals of salt. Explain that most crystals are very small. Ask what the magnifying glass does.

Have them count the sides (or points) of the big snowflake. Tell them that snowflakes **always** have 6 sides. Did they know that no two snowflakes are ever alike? Each one is different. Have them trace some of the snowflake’s **pattern** with their fingers.

**WEEKLY LAB**

**You need: warm water, Epsom salt, a large jar or container, a measuring cup, a tablespoon.**

**Each student will need: a magnifying glass (hand lens), a small paper cup, and a dark-colored plastic plate divided into 3 sections.** (*SEE the* ***Growing Crystals Box*** *on the first page for more information.)*

This lab will show your students how salt crystals grow as the water around them evaporates.

Put a small amount of Epsom salt in **one section** of their plates. Then pour about 30 ml (1/8 cup) of plain water in their paper cups. Have them pour this into the **second section** of their paper plates.

Then tell them to watch as you **stir** 5 Tbps of Epsom salt into 750 ml (3 cups) of water. Ask them if this liquid looks clear. Pour 30 ml (1/8 cup) of this solution into each of their paper cups. Tell them to pour this, in a thin layer, into the **last section** of their plates.

Have them look carefully at each section of their plates with a magnifying lens.

Finally, have them put their plates in an area where they **won’t be disturbed!**  *This is important, because their plates cannot be moved if the crystals are to form properly.*

When all the water has evaporated (usually overnight, have them look at their plates again with their hand lens. Ask them what they **observe**. The strong the magnifying lens, the better they will be able to view their crystals. You can also try this with powdered sugar, so they can see another type of crystal form.

**Level A**

**WEEKLY LAB**

See TN Level Pre-A – WEEKLY LAB – for directions.

**In addition, you will need: powdered sugar, a second small paper cup for each student.**

I the same section as the dry Epsom salt, put a small amount of dry powdered sugar for them to compare. Then, instead of using plain water for the **third section** of their plates as in the Pre-A LAB, make a solution of 2 ¼ cups of powdered sugar to 750 ml (3 cups) of warm water. Pour 30 ml (1/8 cup) of this solution into their second paper cups. Have them pour this, in a thin layer, into the **third section** of their plates. Follow the remaining directions in Pre-A LAB>

Finally, using their hand lens, have them compare the sugar and salt crystals that are formed after all the water is evaporated.

**Level B**

**WEEKLY LAB**

…Encourage them to look at their plates before going home, so they can observe the evaporation process.

After they have completed this lab and compared the crystals that were formed, discuss why using plain water *for comparison* was a good idea for this scientific experiment.

**Level C**

**WEEKLY LAB**

...In addition, after the water has evaporated, have your students draw the crystals they see through their magnifying lens.

**Level D - F**

**WEEKLY LAB**

…This lab will show your students how crystals grow as the water around them evaporates….

…After they have compared the crystals that were formed, discuss why using plain water **for comparison** was a good idea for this scientific experiment. Encourage all ideas about what happens when the sugar and salt crystals are added to the water, but reinforce the idea that they become smaller and smaller as they dissolved in the water. The crystal molecules mixed with the water molecules to form a solution.

**Level F**

**WEEKLY LAB**

**For Experiment A:** TN Level E – WEEKLY LAB.

**For Experiment B:** Their cube will use 12 toothpicks and 8 marshmallows. There are 6 square sides, 12 edges and 8 corners.

**Challenge**

**Answers: 14 cubes** (11 in the front section and 2 in the other corners) are needed to finish the big cube. The completed cube would consist of **64 small cubes.** As an additional activity, have them try to draw a detailed copy of this cube.

**Puzzle**

If a particular crystal pattern is in question when scoring the game, have third student (or the whole class) decide if it is acceptable and meets the “crystal pattern” criteria.

If there are any questions about a pattern’s symmetry, have them copy the pattern, cut it out, and see if it will fold exactly in half.

Explain that the patterns they’ve created in this game are similar to the “regular, orderly patterns” of the molecules in crystals.