

Rapid Crystallization

Objective:

- To investigate the growth of crystals under different temperature conditions.

Science Standards:

Science as Inquiry
Physical Science
- properties of objects and materials
Unifying Concepts and Processes
Change, Constancy, & Measurement

Science Process Skills:

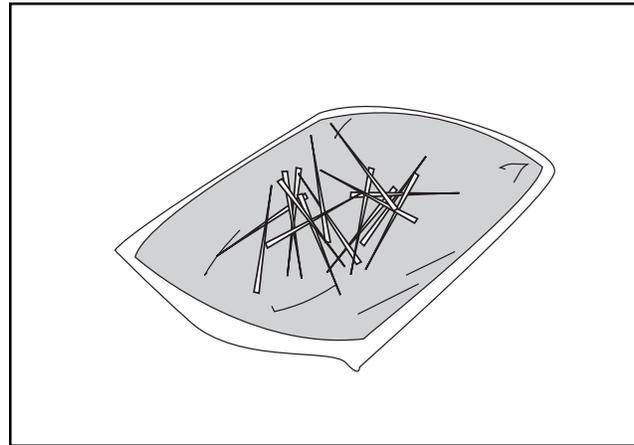
Observing
Communicating
Measuring
Collecting Data
Inferring
Predicting
Interpreting Data
Controlling Variables
Investigating

Mathematics Standards:

Communication
Measurement

Activity Management:

This activity is best done with cooperative learning groups of two or three students. This will minimize the number of heat packs that have to be obtained. Heat packs are sold at camping supply stores. It is important to get the right kind of pack. The pack, sold under different names, consists of a plastic pouch (approximately 9 by 12 centimeters in size) containing a solution of sodium acetate and water and a small metal disk. When the disk



The rapid growth of crystals in a heat pack is observed under different heating conditions.

MATERIALS AND TOOLS

Heat pack hand warmers
(1 or more per group)
Water boiler (an electric kitchen
hot pot can be used)
Styrofoam food tray
(1 per group)
Metric thermometer
(1 or more per group)
Observation and data table
(1 per student group)
Cooler
Clock or other timer

clicked or snapped, crystals begin to form and heat is released. The pack can be reused by reheating until all the crystals are dissolved.

Assemble all the materials needed for the activity in sets for the number of student groups you have. Prepare the heat packs by heating any that are solidified until all the crystals dissolve.

Allow one half of the packs to cool to room temperature. Maintain the other packs at a temperature of about 45°C. This can be done by placing the packs in an insulated cooler with some hot water until the packs are needed.

Before starting the experiment, discuss the data collection procedure. To reduce heat conductivity problems, heat packs are placed on the Styrofoam food tray with the bulb of a thermometer slipped between the pack and the tray. Discuss with the students why the tray is necessary and ask them where the best placement of the bulb should be. Remind students that the thermometer should be placed the same way for each test. Give each student group one student data sheet for each test to be performed.

Begin with observation of the room temperature pack first. The students should be prepared to make observations immediately after the disk is clicked. Complete crystallization should take less than a minute. Since the crystallization process is dramatic, demonstrate the clicking process with another heat pack and pass it around for students to feel. If you have some sort of video display system, show crystallization on the television as it is happening. This may help students focus on the investigation when they start their own packs crystallizing. Distribute the second pack after observations of the first pack are complete. Crystallization of the second pack will take several minutes to complete.

Students will discover that heat packs with higher initial temperatures will take longer to crystallize. Crystals will be more defined than those forming in packs with cooler initial starting temperatures. Depending upon the initial temperature, crystals may resemble needles or blades. Gravity will influence their development. Crystals will settle to the bottom of the pack and intermingle, causing distortions. Crystals forming in an initially cool heat packs will be needlelike but, because so

many form at once, the growth pattern will be fan-shaped.

Use the questions below as a guide to discuss the results of the investigation.

1. Is there any relationship between the initial temperature of the pouch and the temperature of the pouch during crystallization?
2. Is there a relationship between the initial temperature of the pouch and the time it takes for the pouch to completely solidify?
3. Do other materials, such as water, release heat when they freeze?

Assessment:

Collect the student work sheets.

Extensions:

1. Discuss what might happen if the heat pack were crystallized in microgravity. What effect does gravity have? Hold the pack vertically with the steel disk at the bottom and trigger the solidification. Repeat with the disk at the top.
2. Try chilling a heat pack pouch in a freezer and then triggering the solidification.



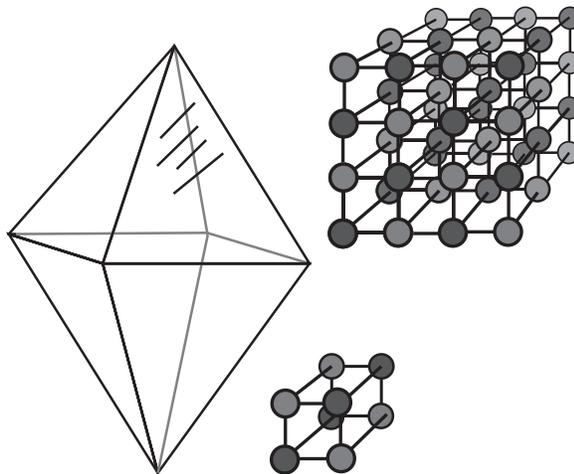
Heat Packs and Crystals

Crystals are solids composed of atoms, ions, or molecules arranged in orderly patterns that repeat in three dimensions. The geometric form of a crystal visible to the naked eye can provide clues to the arrangement inside. Many of the unique properties of materials, such as strength and ductility, are a consequence of crystalline structure.

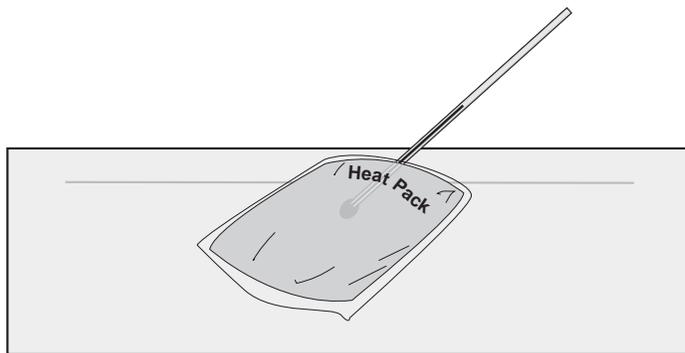
It is easy to get confused about the nature of crystals because the word crystal is frequently misused. For example, a crystal chandelier is not crystal at all. Crystal chandeliers are made of glass which is a solid material but does not have a regular interior arrangement. Glass is called an *amorphous* material because it does not have a regular interior arrangement of atoms.

Scientists are very interested in growing crystals in microgravity because gravity often interferes with the crystalgrowing process, leading to defects forming in the crystal structure. The goal of growing crystals in microgravity is not to develop crystal factories in space but to better understand the crystal-growing process and the effects that gravity can have on it.

In this activity, you will be investigating crystal growth with a hand warmer. The hand warmer consists of a plastic pouch filled with a food-grade solution of sodium acetate and S water. Also in the pouch is a small disk of stainless steel.



Snapping the disk triggers the crystallization process. (The exact cause for this phenomena is not well understood.) The pouch is designed so that at room temperature the water contains many more molecules of sodium acetate than would normally dissolve at that temperature. This is called a supersaturated solution. The solution remains that way until it comes in contact with a seed crystal or some way of rapidly introducing energy into the solution which acts as a trigger for the start of crystallization. Snapping the metal disk inside the pouch delivers a sharp mechanical energy input to the solution that triggers the crystallization process. Crystallization takes place so rapidly that the growth of crystals can easily be observed. Heat is released during the precipitation that maintains the pouch temperature at about 54°C for about 30 minutes. This makes the pouch ideal for a hand warmer. Furthermore, the pouch can be reused by reheating and dissolving the solid contents again.



Team Member Names:

Heat Pack Experiment Data Sheet

Test number: _____

Initial temperature of pouch: _____

Temperature and time at beginning of crystallization: _____

Temperature and time at end of crystallization: _____

Length of time for complete crystallization: _____

Describe the crystals (shape, growth rate, size, etc.)



Sketch of Crystals

Test number: _____

Initial temperature of pouch: _____

Temperature and time at beginning of crystallization: _____

Temperature and time at end of crystallization: _____

Length of time for complete crystallization: _____

Describe the crystals (shape, growth rate, size, etc.)



Sketch of Crystals

