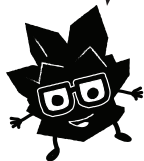


**GEEK
& CO.
SCIENCE!**



PROJECT KIT **Ages
8+**

CrYsTaL JEWELRY



Warning.

Not suitable for children under 8 years. For use under adult supervision. Contains some chemicals which present a hazard to health. Read the instructions before use, follow them and keep them for reference. Do not allow chemicals to come into contact with any part of the body, particularly the mouth and eyes. Keep small children and animals away from experiments. Keep the experimental set out of reach of children under 8 years old. Eye protection for supervising adults is not included.

WARNING — This set contains chemicals and/or parts that may be harmful if misused. Read cautions on individual containers and in manual carefully. Not to be used by children except under adult supervision.

Franch-Kosmos Verlags-GmbH & Co. KG, Pfizerstr. 5-7, 70184 Stuttgart, Germany | +49 (0) 711 2191-0 | www.kosmos.de
Thames & Kosmos, 301 Friendship St., Providence, RI, 02903, USA | 1-800-587-2872 | www.thamesandkosmos.com
Thames & Kosmos UK Ltd, Goudhurst, Kent, TN17 2QZ, United Kingdom | 01580 212000 | www.thamesandkosmos.co.uk

THAMES & KOSMOS



Safety information

WARNING.

Not suitable for children under 3 years. Choking hazard — small parts may be swallowed or inhaled. Strangulation hazard — long cords may become wrapped around the neck.

Keep the packaging and instructions as they contain important information. This kit contains functional sharp-pointed wires. Do not injure yourself!

First aid information

Advice in case any accidents should happen during experimentation.

- 1. In case of eye contact:** Wash out eye with plenty of water, holding eye open if necessary. Seek immediate medical advice.
- 2. If swallowed:** Wash out mouth with water, drink some fresh water. Do not induce vomiting. Seek immediate medical advice.
- 3. In case of inhalation:** Remove person to fresh air.
- 4. In case of skin contact and burns:** Wash affected area with plenty of water for at least 10 minutes.
- 5. In case of doubt,** seek medical advice without delay. Take the chemical and its container with you.
- 6. In case of injury** always seek medical advice.

Poison control

Poison Control Centers (United States)

In case of emergency, your nearest poison control center can be reached everywhere in the United States by dialing the number:

1-800-222-1222

Local Hospital or Poison Centre (Europe)

Record the telephone number of your local hospital or poison centre here:

Write the number down now so you do not have to search for it in an emergency.

Advice for parents and supervising adults

With this crystal growing set, you will be accompanying your child on a journey into the fascinating world of crystals. It is natural to have questions about the safety of a kit that contains chemicals. The experimental equipment in this kit complies with safety standards that specify the safety requirements for crystal growing sets. These standards impose obligations on the manufacturer, such as forbidding the use of any particularly dangerous substances. The standards also stipulate that adults should assist their children with advice and assistance in their new hobby.

A. Read and follow these instructions, the safety rules and the first aid information, and keep them for reference.

B. The incorrect use of chemicals can cause injury and damage to health. Only carry out those experiments which are listed in the instructions.

C. This experimental set is for use only by children over 8 years.

D. Because children's abilities vary so much, even within age groups, supervising adults should exercise discretion as to which experiments are suitable and safe for them. The instructions should enable supervisors to assess any experiment to establish its suitability for a particular child.

E. The supervising adult should discuss the warnings and safety information with the child or children before commencing the experiments. Particular attention should be paid to the safe handling of crystal growing chemicals and solutions.

F. The area surrounding the experiment should be kept clear of any

obstructions and away from the storage of food. It should be well lit and ventilated and close to a water supply. A solid table with a heat resistant top should be provided.

G. Substances in non-reclosable packaging should be used up (completely) during the course of one experiment, i.e. after opening the package.

Hot water is used in the production of crystal salt solution. You should devote special care to handling it safely and assist your child when help is needed. Make sure there is no fire risk when heating water on the kitchen stove!

While experimenting, please be careful not to let the crystal salts (chemicals) come into contact with the skin, eyes, or mouth. It is also important not to let the crystal salts, their solutions, or especially the finished crystals get into the hands of young children.

The dye will color things very intensely and may cause stains that can't be washed out of clothing. Keep all tablecloths, curtains, and carpets away from the experiment area.

The work area should not be in the kitchen, as chemicals should be kept strictly separate from foods and kitchen equipment. A cool basement room would be ideal. Do not use any containers or tools in the kitchen after you have used them for growing crystals.

Always get any required equipment and chemicals ready before beginning an experiment. The safety goggles are particularly important!

We hope you and your child have a lot of fun growing crystals!

Safety rules

Read this before starting any experiments

1. Read these instructions before use, follow them and keep them for reference.
2. Keep young children, animals, and those not wearing eye protection away from the experimental area.
3. Store this experimental set and the final crystal(s) out of reach of children under 8 years of age.
4. Clean all equipment after use.
5. Ensure that all empty non-reclosable packaging is disposed of properly.
6. Wash hands after carrying out experiments.
7. Do not eat or drink in the experimental area.
8. Do not allow chemicals to come into contact with the eyes or mouth.
9. Do not apply any substances or solutions to the body.
10. Do not grow crystals where food or drink is handled or in bedrooms.
11. Do not use any equipment which has not been supplied with the set or recommended in the instructions for use.
12. Take care while handling hot water and hot solutions.
13. Ensure that during growing of the crystal the container with the liquid is out of reach of children under 8 years of age.
14. Do not use any eating, drinking, or other kitchen utensils for your experiments. Any containers or equipment used in your experiments should not be used in the kitchen afterward.
15. If chemicals should come in contact with eyes, mouth, or skin, follow the first aid advice (inside front cover of this manual) and contact a doctor if necessary.
16. Never work alone. An adult should always be present. Also, pay attention to the information on the chemical labels, the “Information about hazardous substances” on page 3, as well as the safety information provided with the individual experiments (for example, having to do with handling hot liquids).
17. Be particularly careful with hot burners, and don't forget to turn them off after use! Do not inhale hot vapors!
18. Pay special attention to the quantity specifications and the sequence of the individual steps. Only perform experiments that are described in this instruction manual.
19. Always wear eye protection. If you wear corrective eyeglasses, you will need protective goggles for those who wear corrective eyeglasses. When working, wear appropriate protective clothing.
20. Always hold containers of hot materials such that their openings are pointing away from yourself or others. Do not inhale vapors that are released while heating!

NOTE! *The additionally required items are highlighted in italic script in the individual experiments. Before starting the experiments, carefully read through everything that will be required and make sure to have all the materials ready.*

Instructions for using the safety goggles

Item No.
052297

Use The safety goggles are only to be used with the experiment kit. No other type of application is permitted. Wear the glasses in such a way that the eye area is protected. If necessary, adjust the elastic band to the head circumference of the child. The safety goggles should be used together with contact lenses. Wearers of corrective eyeglasses need special safety goggles for people who wear glasses.

Duration of use Always wear the safety goggles when performing your experiments. Not intended for long-term use. The duration of wear should not exceed the time of the experiment.

Storage Store safety goggles at room temperature in a dry room. After the experiment, return them to their place in the kit box, to keep them from being scratched.

Cleaning Do not clean the safety goggles when they are dry. Clean them with plain water and, if necessary, with a mild household liquid detergent, and dry them off with a soft cloth.

Maintenance In case of defective safety goggles or scratched lenses, exchange the glasses for an equivalently constructed pair.

Inspection Check the safety goggles to make sure they are in good condition, and replace them if they are damaged.

Warning Some extremely sensitive individuals may under certain circumstances experience an allergic reaction to skin contact with some materials.

Replacement These safety goggles are available as a replacement part.

The safety goggles are tested per European Directive 89/686/EWG (personal protective equipment).

Notified body Certification center 0197 · TÜV Rheinland Product Safety GmbH · Am Grauen Stein · D-51105 Köln, Germany

Manufacturer Franckh-Kosmos Verlags-GmbH & Co. KG · Pfizerstrasse 5-7 · 70184 Stuttgart, Germany

Information about hazardous substances

Here is information about handling the substances contained in this kit.

Please note the following hazard and precautionary statements for the chemicals contained in this kit:

Potassium aluminium sulfate (alum):

Avoid breathing dust. Do not get in eyes, on skin, or on clothing.

Aqueous solution of potassium dihydrogen phosphate ("magic water:")

Not hazardous. Used as a food additive (E340).

Dye tablets (5): Not hazardous. Food coloring.

Warning. The following applies to all chemicals: Store locked up. Keep out of reach of children.

This primarily applies to young children, but also to older children who — unlike the experimenter — have not been appropriately instructed by adults.

Also follow this precautionary statement: **IF SWALLOWED:** Get immediate medical advice/attention and have product container or label of chemical substance at hand.

If any chemicals inadvertently get onto the skin, rinse off immediately under running water. Always be careful not to inhale chemical dust or powder when experimenting.

Advice for growing crystals safely

Before each experiment, always read through the instructions. Only use materials that are mentioned in the instruction manual. Never bring the substances you are handling into contact with your body, particularly with eyes or mouth. Always be particularly careful with hot burners, and remember to turn them off after use! **Always wear your safety goggles when handling chemicals.**

Your experiment area should be set up in a quiet room. If there are any small children or pets in the house, you should be able to close off the room so they can't get to the chemicals or knock over your crystal-growing jars, which you will have to leave standing for several days. The temperature in the room shouldn't vary too much (no full sun through the window, for example), since the solubility of the substances is temperature-dependent and unwanted heating can cause already-formed crystals to dissolve.

Use a pair of scissors to cut open the packets at one corner. Never use your teeth. Make sure not to cut the printed area so it becomes unreadable.

If the crystal salt has formed clumps, it does not mean there is anything wrong with the quality of the contents. Rather, it just means that some moisture (from the air, for example) has gotten in. This will not affect its function. The age of your crystal salt will likewise make no difference.

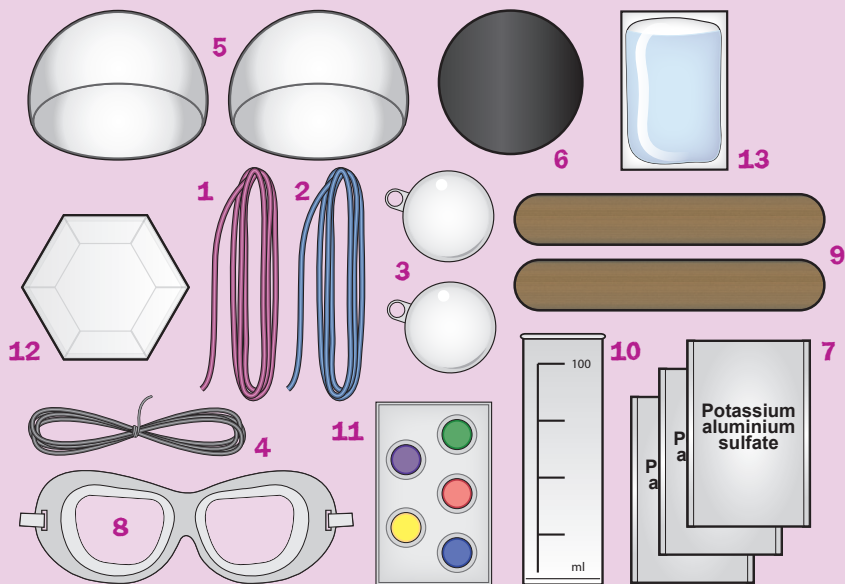
The kitchen is not appropriate for your experiments, since there is too great a risk that chemicals will get into foods or that someone will inadvertently swallow these substances by mistaking them for food.

A small, quiet, cool, and ideally lockable basement room is best. For your workplace you can use a sturdy table with a tough, heat-resistant surface that should always be kept covered with newspaper. Don't forget to clean up after your experiments and to wipe the work surface clean.

Cleanliness is especially important in chemistry. So always clean up any used containers and your workplace immediately after finishing the experiments. Then wash the containers with clean water and dry them with a paper towel, which you should then throw into the trash. Since you will only be working with small amounts of a harmless chemical, you can simply wash any liquid waste down the sink with plenty of water. Solid waste can go into the household garbage. When disposing of dyed liquids, be careful to pour them right into the drain so you don't stain the sink.

Once you have finished them and they have dried, always store any smaller crystals in the lockable jewelry box. Larger specimens can be kept in a lockable cupboard or on a high shelf, out of the reach of small children.

KIT CONTENTS



- | | | | |
|---|--------------------------------------------------------|----|----------------------------------------------------------------------------------|
| 1 | Chenille wire, pink (50 cm) | 8 | Safety goggles |
| 2 | Chenille wire, blue (50 cm) | 9 | Wooden stirring stick (2) |
| 3 | Dome pendant box (2) | 10 | Measuring beaker, 100 ml |
| 4 | Pendant cord (100 cm) | 11 | Food color dye tablets (5) |
| 5 | Clear plastic hemispheres (2) | 12 | Hexagonal box |
| 6 | Round black cardboard | 13 | Packet of magic water
(aqueous solution of potassium
dihydrogen phosphate) |
| 7 | Potassium aluminium sulfate
powder (alum), 50 g (3) | | |

YOU WILL ALSO NEED: *Two glass jars, water, ruler, scissors, pencil or skewer, cooking pot, old spoon, stove, pot holders, labels, safety pin, double-sided tape, small screw driver, paper clip, string*

Hey Crystal Jewelers!

Ready to grow some beautiful, colorful crystals and make some pretty jewelry and crafts? You can grow crystals for a pendant, a brooch, a crystal ball, and fun crystal wireframe shapes. Quartz the Geeker will be your guide!

Hi, I'm Quartz!



PART 1

CRYSTAL WIREFRAMES

Did you know the crafting term for “pipe cleaner” is “chenille stem?” Well, in this experiment, you sure won’t be cleaning any pipes with them. You’re going to be growing crystals on them!

Growing crystals on pipe cleaners

You will need:

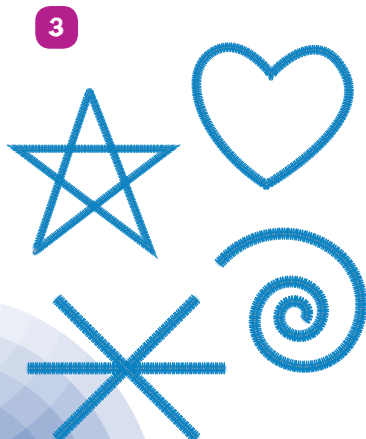
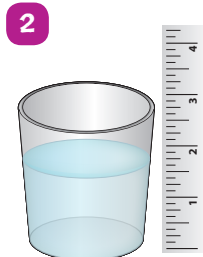
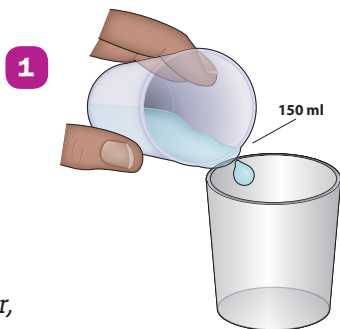
Pipe cleaners, potassium aluminium sulfate (alum) powder (50 g), dye tablet, goggles, two glass jars, water, ruler, scissors, pencil or skewer, cooking pot, old spoon, stove, pot holders, labels

Here’s how:

1 Find a small glass jar to use. First you want to measure how high 150 ml of water rises in the jar, so you know how big of a pipe cleaner shape you can make. The pipe cleaner shape needs to fit entirely in the jar under the surface of the water. Fill the jar with 150 ml of water.

2 Measure how high the water rises in the jar. This is the maximum height of your model. The maximum length and width are determined by the diameter of your jar. Set the jar of water aside.

3 Now make your pipe cleaner shape. You can make any shape you want. Here are some easier shapes. On the next two pages, there are instructions for how to make a cool-looking, but more difficult, crystal shape.



4 Lay the pipe cleaner along a ruler.

5 Bend the pipe cleaner to form a 120 degree angle at 1.5 inches.

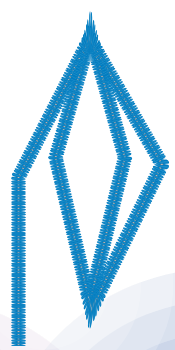
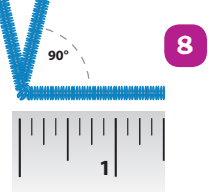
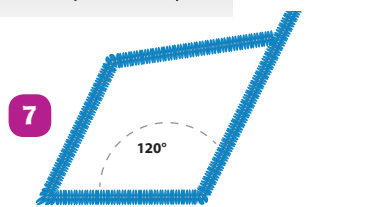
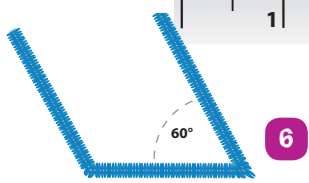
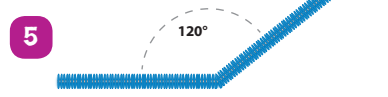
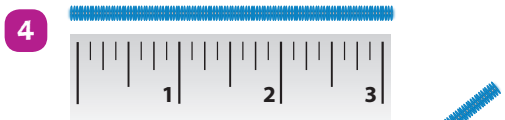
6 Bend the pipe cleaner again at 1.5 inches, this time to form a 60 degree angle.

7 Bend it again at 1.5 inches, to 120 degrees, and wrap the wire around to close the shape.

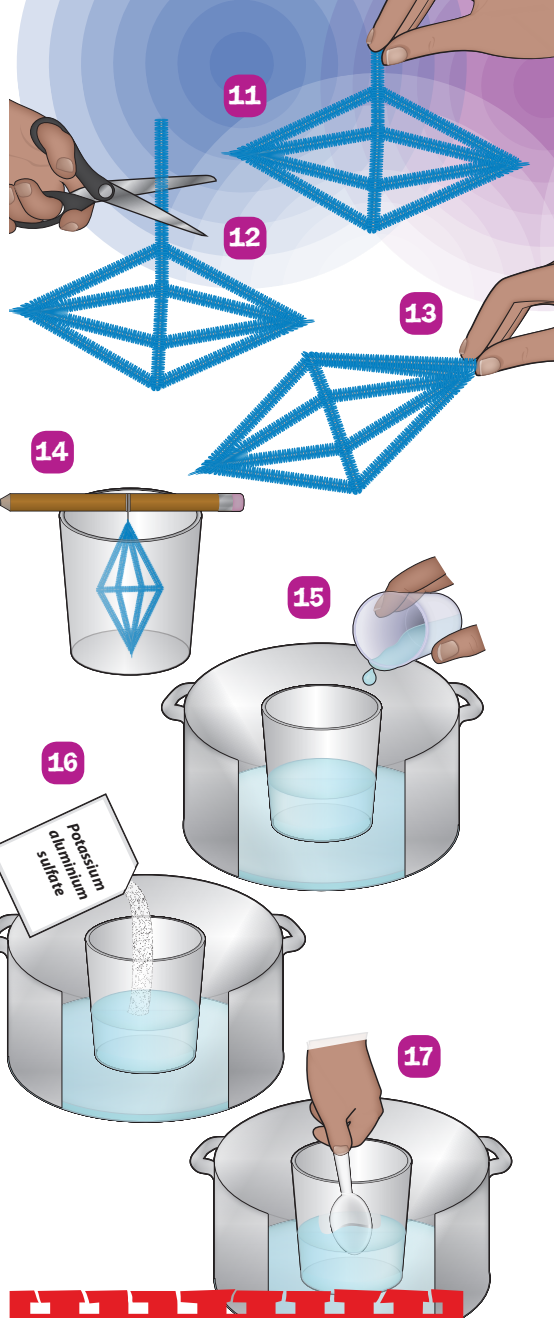
8 Now starting with the free end of the pipe cleaner from the diamond shape, make another diamond shape just like the first, but at a 90 degree angle to the first.

9 Continue bending the pipe cleaner to make the second diamond shape at a right angle to the first. Here it is almost finished.

10 Close off the second diamond shape by bending the wire around the first and cutting it off.



- 11 Now wrap a pipe cleaner around the middle of the diamond cage shape.
- 12 Cut the end so there is just a little piece of pipe cleaner left to wrap around and close the shape.
- 13 Wrap the end around to close the shape.
- 14 Hang the pipe cleaner shape in the jar of water you measured at the beginning. Make sure the pipe cleaner shape fits entirely in the water. Hang it with a thread from a pencil, skewer, or chopstick.
- 15 Pour the water into another heatable jar inside a double-boiler. A double-boiler is just a larger pot that holds a smaller vessel in a bath of water, to keep the inner jar from overheating.
- 16 Pour 50 grams of potassium aluminium sulfate powder (also known as alum) into the water in the jar.
- 17 Heat and stir until the alum is dissolved.
- 18 Choose the food color dye tablet you want to use. Add a piece of it to the jar and let it dissolve in the solution.



CAUTION!

Have an adult help you! Be careful not to burn yourself on the hot stove, and don't forget to turn the stove off afterwards!

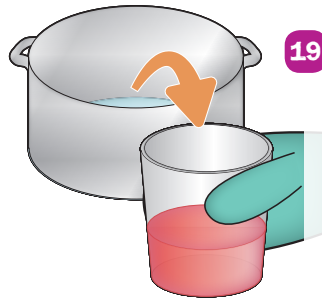
19 Remove the jar from the pot with pot holders. Have an adult help you.

20 Pour the solution from the jar into the jar with the pipe cleaner shape.

21 Let the pipe cleaner shape sit in the solution for 2-4 days, until the crystals have grown to your liking.

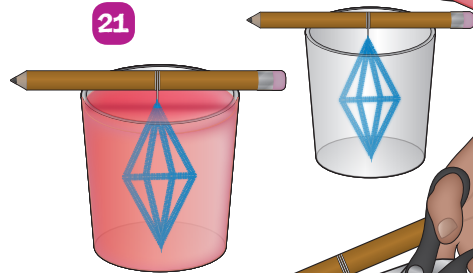
22 When your crystal is done growing, remove it from the solution, let it dry, and cut the string off.

23 You're done! Pipe cleaners never looked so chic! Keep your crystal out of reach of young children and pets!

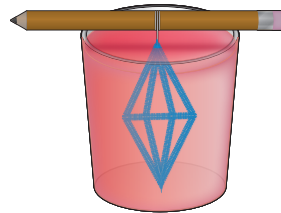


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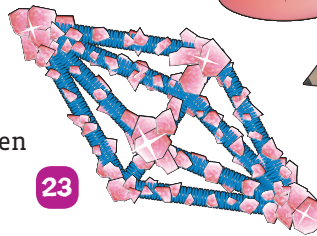
20



21



22



23

**GEEK
OUT!**

SATURATED SOLUTIONS

A solution is said to be **saturated** when it contains as much of a substance as can possibly dissolve in it at a given temperature. A saturated salt solution, for example, holds 16 g of salt per 100 g of solution at 20 °C. But if you heat a saturated solution, it becomes capable of dissolving more of the substance. If, on the other hand, you cool a saturated solution, it becomes **supersaturated**: Now it contains more salt than it can hold at the lower temperature, and crystals form!

SOLUBILITY OF ALUM

°C	Grams per 100 grams of water
0	5.7
10	8.5
20	12
30	18.5
40	25
50	36.8
60	58.5
70	94.4
80	95

100 grams of water is about 100 ml of water!

PART 2

A REAL CRYSTAL BALL



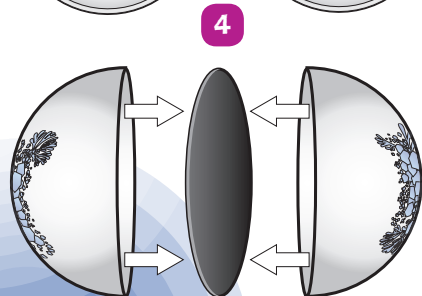
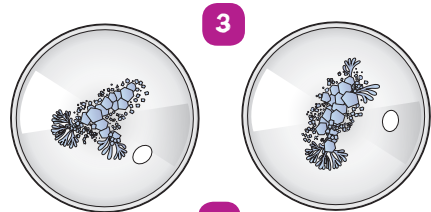
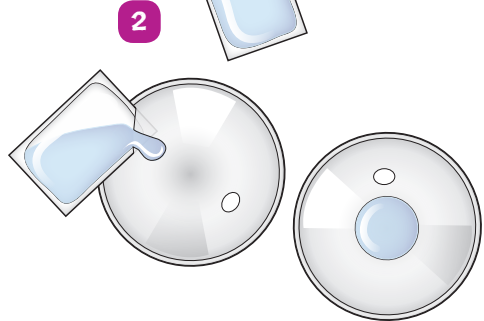
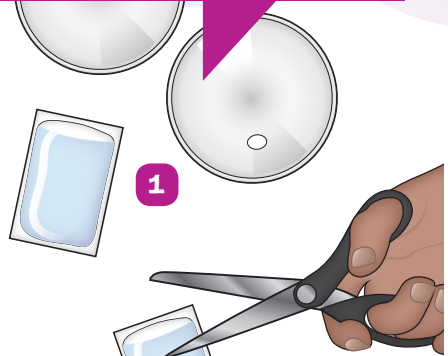
Grow crystals inside an ornamental orb

You will need:

Clear plastic hemispheres, round black cardboard, packet of magic water (potassium dihydrogen phosphate), scissors, paper clip, string

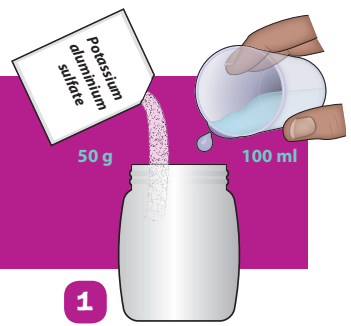
Here's how:

- 1 Place both clear hemispheres on the table, with their openings facing up. You may want to stabilize them to keep them from tipping over.
- 2 Cut the bag of magic water. Pour half of the contents in each hemisphere, below the hole.
- 3 Let the solution evaporate. This may take up to a week.
- 4 Piece the two halves together with the black cardboard disk in the middle.
- 5 Hang your crystal orb using a bent paper clip as shown. It will catch the light and look beautiful!



PART 3

CRYSTAL BLING!



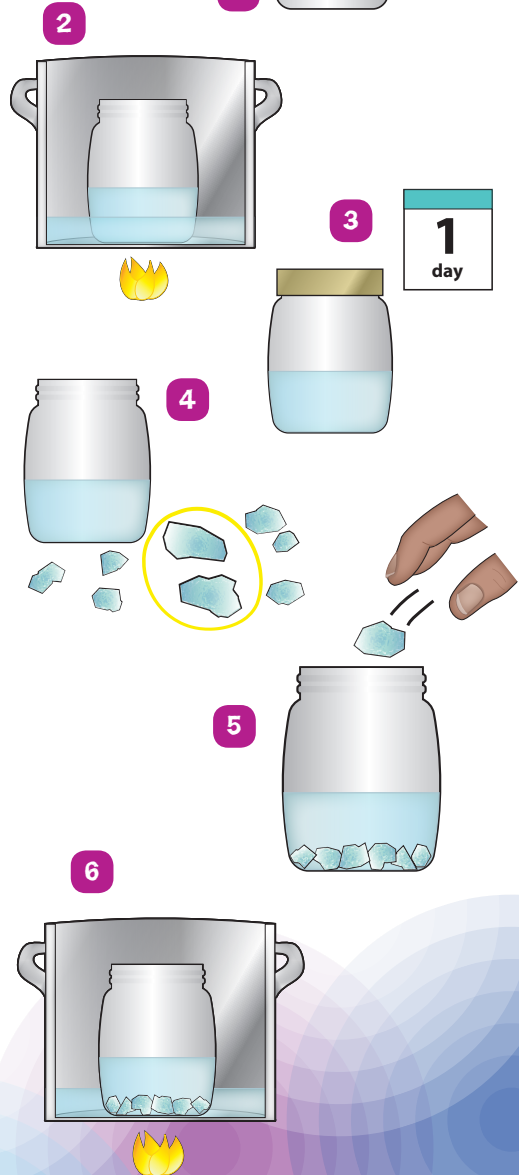
Crystals for pendants and brooches

You will need:

Alum powder (50 g), dye tablet, dome pendant box, pendant cord, hexagonal box, safety goggles, two glass jars, water, scissors, pencil or skewer, cooking pot, old spoon, stove, pot holders, labels, rag, safety pin, double-sided tape, small screwdriver

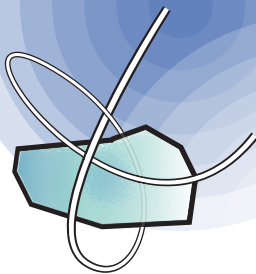
Here's how:

- 1 Mix 50 grams of alum powder and 100 ml of water in a heat resistant glass jar.
- 2 Heat the jar in a double-boiler until the alum dissolves completely.
- 3 Remove the solution from the double-boiler, let it cool, cover it, and let it sit for one day.
- 4 Remove the two biggest, nicest crystals from the solution.
- 5 Pour the rest of the crystals back in the solution.
- 6 Reheat the solution in the double-boiler to redissolve it. Remove it from the heat and let it cool a bit.



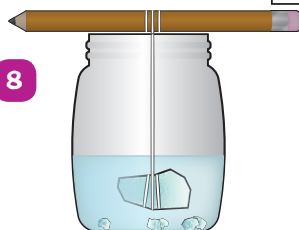
7 Tie a string around the large crystal.

7



8 Tie the string to the middle of a pencil. Place the pencil on the top of the jar of solution so that the crystal is suspended in the exact center of the solution, and no part of the crystal is touching the side of the jar. Cover with a rag and wait one to two days.

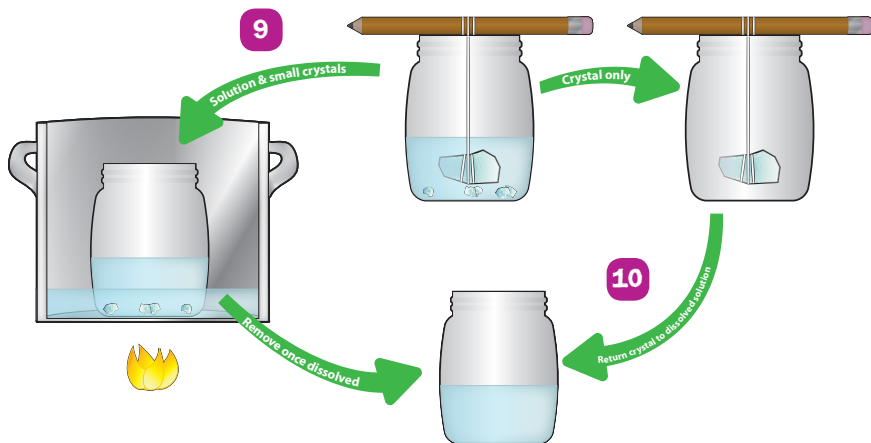
8



1-2
days

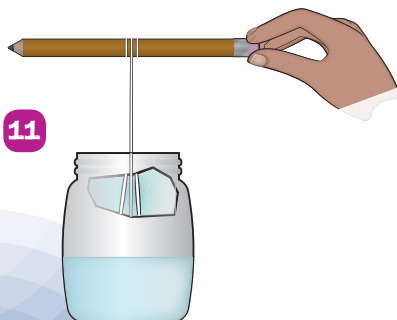
9 If you want your crystal larger still, pour the solution back into a jar in a double-boiler and redissolve, leaving only the suspended crystal in the original jar.

9



10 Once the redissolved solution is cool, move the crystal to the jar with the solution and wait another one to two days.

11



11 When you are happy with the size of your crystal, remove it from the solution. Now it's time to put it either in the pendant box or the hexagonal box.

12

12 You can put a piece of double-sided tape inside the hexagonal box or the pendant box to hold the crystal in place.

13 Press the crystal to the double-sided tape.

To finish the hexagonal box brooch:

14 Line up the box lid and base so that the grooves on the sides are aligned.

15 Snap the box shut.

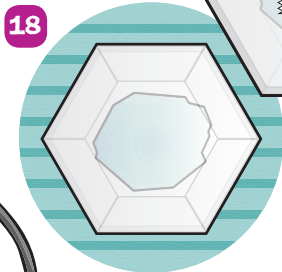
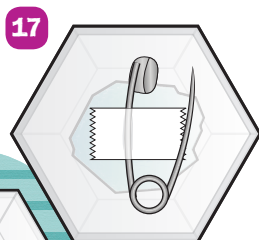
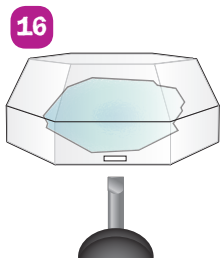
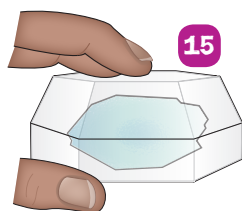
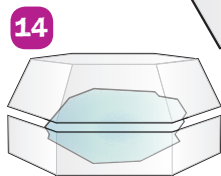
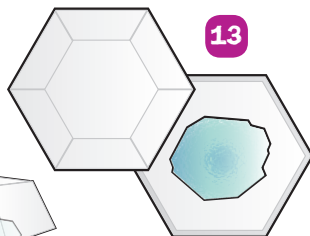
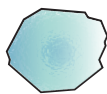
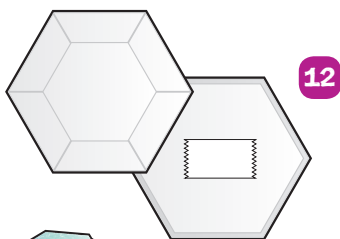
16 For future reference, to open the box again, insert a small screwdriver into the slot on the side to pop it open.

17 To make a brooch, tape a safety pin to the back of the box.

18 Pin the box to your shirt!

To finish the dome pendant:

19 Cut the black cord to the correct length. Tie it to the box and hang it around your neck.



CAUTION!

Do not wear the necklace during sports or when playing actively, such as on the playground. Take care that you do not entangle yourself in the cord. It is best to wear it close around your neck. Use the knot shown here to make the length of the necklace adjustable.

HOW DO CRYSTALS “KNOW” HOW TO GROW?

Let's imagine an Egyptian pyramid to illustrate how crystals grow. The Great Pyramid of Giza, for example, is made of over two million rectangular blocks that are layered on top of one another to form a pyramid shape.



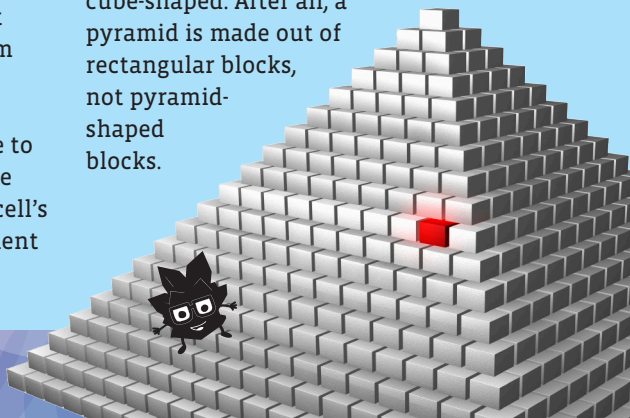
This is much like how a crystal is built up, except that its building blocks are extremely tiny. They are not much bigger than atoms. Those crystal building blocks are called **unit cells**. Some unit cells are **molecules** — groups of atoms put together in specific patterns. An example of this would be the sugar crystals in rock candy. Other unit cells may simply be **identical atoms** (for example, diamond crystals are made of carbon atoms). And then there are unit cells made out of **ions** — electrically charged atoms or groups of atoms.

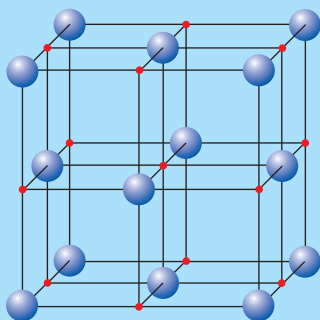
There are positively and negatively charged ions, which attract each other and stick together like the north and south poles of magnets. Materials made out of ions are called **salts**. Examples include table salt and the alum and monopotassium phosphate salts in this kit.

Each unit cell has a shape unique to the material that composes it. The shape is determined by the unit cell's component parts, their arrangement relative to one another, and the

strength of the forces of attraction holding them together. Some are cube-shaped, others rectangular or rhomboid. All the components always strive to pack together as tightly as possible and to use as much of the available space as they can — a result of the strong forces of attraction between them.

Just like the pyramid with its millions of blocks, crystals grow through the accumulation of these unit cells. Of course, if a unit cell has the shape of a cube, it does not necessarily mean that the resulting crystal will also be cube-shaped. After all, a pyramid is made out of rectangular blocks, not pyramid-shaped blocks.





In the same way, cube-shaped or rectangular unit cells can accumulate to form the shape of a pyramid, or an octahedron “double pyramid.” Alum forms an octahedron crystal made from an accumulation of cube-shaped unit cells.

A crystal in a solution is a very busy building site. Instead of human workers like the ones who built the pyramids, the work is performed by forces of attraction between the atoms, ions, and molecules, along with the ceaseless natural movement of these particles.

These tiny particles are constantly attaching themselves to the developing crystal, pausing for a moment, and whizzing off again. That happens mostly at the corners and edges, somewhat less on the flat surfaces. Usually, the arriving particle does not fit properly at its landing spot, so it immediately leaves. Sometimes, though, just

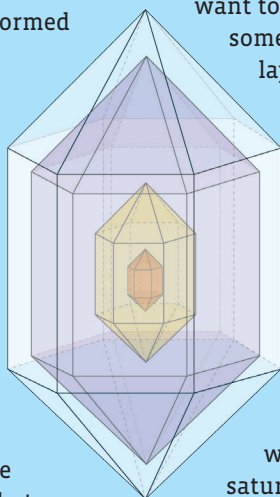
the right type of particle arrives at just the right part of a unit cell as it is forming, and it stays put. Even that kind of particle might scoot off too, but on average more particles that arrive at the right spot will stay there than leave — and so the crystal grows, layer by layer.

Because particles come and go more often at the edges than the flat faces, the smaller crystals in a solution will get even smaller as time passes, while bigger crystals grow larger. With the smaller ones, edges take up a higher proportion of their surface area.

It takes time for the particles to find the right resting spots. If there is not enough time, because too many particles in a supersaturated solution want to settle down all at once,

some of the unit cells form layers on top of one another, or just stick to whatever they happen to land on — the side of the jar, for example. That is why a crystal that grows very slowly from a solution that is only slightly supersaturated is more orderly than one that grows quickly.

And if the solution gets warmer and is no longer saturated? Then the number of particles that fly off outnumber the particles that settle down: the crystal dissolves.



ATOMIC CRYSTAL LATTICES

The ordered, repeating geometrical arrangement of atoms in a crystal is known as the **crystal lattice**.

There are some common lattice structures that are found in many different types of crystals.

A A **simple cubic structure** is one in which the atoms are organized in a simple box or cube shape.

B **Body centered cubic lattices** are like simple cubic structures, except there is a ninth atom in the middle of the cube. This ninth atom fills in a void in the center of the cube created by the other eight atoms.

Because atoms can be thought of as having spherical areas, there are gaps left between them when they are placed side-by-side. These gaps can then be filled by other atoms, as in body centered cubic lattices.

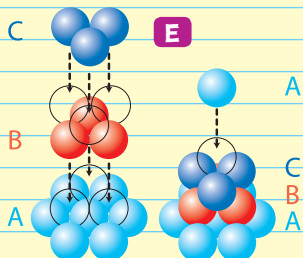
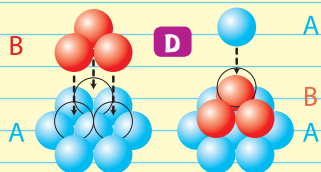
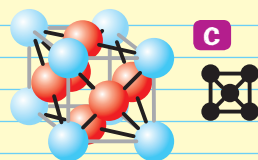
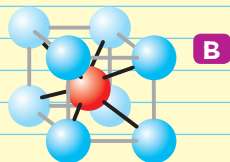
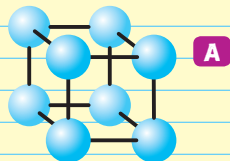
C **Face centered cubic lattices** are like simple cubic structures, except there is an additional atom in the center of each side of the cube. Thus, there are 14 atoms in the cubic structure. Those are the three simplest lattice structures.

There are also structures called **closest packed structures**, where the atoms are packed even closer.

D In **hexagonally closest packed lattices**, atoms in one layer sit in the “groves” formed by the spherical atoms in the layer beneath them. Two unique layers of atoms alternate to form the crystal.

E **Cubic closest packed lattices** are similar to hexagonally closest packed, except that there are three unique layers of atoms.

These lattice configurations illustrate just a few of the many fascinating ways geometry plays a role in the formation of crystals. A good way to understand these shapes better is to try building them yourself in three dimensions, with foam or clay balls and toothpicks for example.

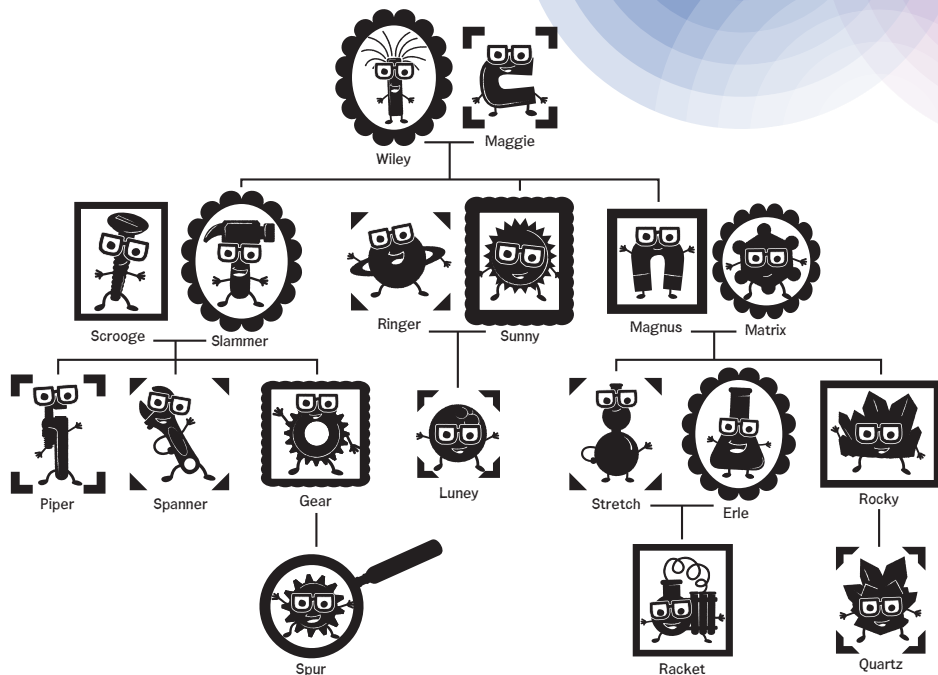




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MEET THE GEEKERS!



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