

The following information is excerpted from the National Crystal Growing Competition for Canada. The website is the Chemistry Institute of Canada (<http://www.cheminst.ca>). However to see the original it is easier to Google 'crystal growing canada'

What is a Crystal?

A crystal is a solid that consists of the various atoms, ions, or molecules being arranged in a uniform repeating pattern. This results in the material having a specific shape and colour, and having other characteristic properties. Diamond (used in jewellery and cutting tools) is an example of a crystal. It is made of pure carbon. Graphite (used in pencils and lubricants) is also a crystal made from carbon. Salt and sugar are also examples of crystals.

Recrystallization is a process that has been used to purify solid material by dissolving the solid (called a solute) in an appropriate liquid (called a solvent) and then having the material come out of solution in crystalline form. Depending upon conditions, one may obtain a mass of many small crystals or one large crystal.

If you are accessing the above website, Click on these links for more detailed information:

- [crystal types](#)
- [shapes and sizes](#)
- [light and colour](#)
- [how crystals form](#)
- [Frequently asked crystal questions](#)

How to Grow Crystals

First Stage: Grow a Seed Crystal

The idea is to grow a single crystal, not a bunch of crystals. You will first need to grow a small perfect crystal, your seed crystal, around which you will later grow a large crystal. It is therefore essential to avoid excessive rapid growth, which encourages the formation of multiple crystals instead of a single crystal.

What You Need

- Substance to be crystallized;
- Distilled or demineralised water;
- A shallow dish (e.g., Petri);
- Heating plate or stove;
- Fishing line (1 to 2 kg strength);
- A small wood rod (e.g., popsicle stick);
- A magnifying glass (optional).

Important Things to Know

- How much substance you have to work with, which you can determine by weighing it on a balance.
- The solubility of the substance in water at room temperature, which you can obtain from a chemistry reference book.
- It would also be useful to know the solubility of the substance at elevated temperatures, which is information that may also be available in a reference book such as Handbook of Chemistry and Physics, 45th Ed (1964-5)]

What to Do

- Warm about 50 mL (1/4 cup) of water in a glass container.
- Dissolve a quantity of the substance to produce a saturated solution at the elevated temperature.
- Pour the warm solution into a shallow dish.
- Allow the solution to cool to room temperature.
- After a day or so, small crystals should begin to form.
- Remove some of the crystals.
- With a magnifier select a beautiful and transparent small crystal. This will be your seed crystal.
- Tie the seed crystal with the fishing line by using a simple overhand knot.
- Suspend the seed crystal in a shallow (1 to 2 mm deep) small volume (about 1 to 2 mL) saturated solution (for example, in a cover or a Petri dish) for some time (1 to 2 days).
- Check with the magnifier that the seedling crystal is well-fixed to the line by its beginning growth. This step is very important because one can lose several days of growth if the 'beginning growth' is not regular or not along the structure of the seedling crystal. It is worth checking properly before going on with the regular crystal growth.

Second Stage: Grow a Large, Single Crystal

Now you are ready to proceed with the preparation of a large single crystal.

Once you have mastered this step, you may be interested in trying to grow single crystals in the presence of introduced 'impurities' that may give different crystal colours or shapes.

What You Need

- Substance to be crystallized;
- A seed crystal of the substance to be crystallized on a fishing line;
- Distilled or demineralized water;
- A small wood rod or popsicle stick;
- Thermometer;
- Balance;
- Plastic or glass container;
- Heating plate;
- Beaker of 2 to 4 litres volume;
- Thermostated bath (optional);
- Slow revolution motor (1 to 4 rotations per day) (optional).

Important Things to Know

- How much substance you have to work with, which you can determine by weighing it on a balance.
- The solubility of the substance in water at room temperature, which you can obtain from a chemistry reference book.
- It would also be useful to know the solubility of the substance at elevated temperatures, which is information that may also be available in a reference book.

How to Prepare a Supersaturated Solution

To grow your large, single crystal, you will need a supersaturated solution.

The amounts of substance and water to be used will depend upon the solubility at room and elevated temperatures. You may have to determine the proper proportions by trial and error (just like the first scientists did).

Method One

1. Place about double the amount of substance that would normally dissolve in a certain volume of water at room temperature into that volume of water. (e.g. If 30 g (about 1 oz) of X dissolves in 100 g (mL) of water at room temperature, place 60 g of X in 100 mL of water.) Adjust the proportions depending upon how much material you have. Use clean glassware.
2. Stir the mixture until it appears that no more will go into solution.
3. Continue stirring the mixture while gently warming the solution.
4. Once all of the substance has gone into solution, remove the container from the heat.
5. Allow the solution to cool to room temperature.

You now have a supersaturated solution.

Method Two

1. Select an appropriate volume of water.
2. Warm this water to about 15–20 deg above room temperature.
3. Add some of your substance to the warm water and stir the mixture to dissolve completely.
4. Continue adding substance and stirring until there is a little material that won't dissolve.
5. Warm the mixture a bit more until the remaining material goes into solution.
6. Once all of the substance has gone into solution, remove the container from the heat.
7. Allow the solution to cool to room temperature.

You now have a supersaturated solution.

Now you Can Grow your Wonderful Crystal

Since the solubility of a substance varies a lot with temperature, it is very important to control the temperature carefully.

If the room temperature is stable then you might be able to leave your apparatus out in the open. If it can vary by even only a degree or two, then it may be necessary to place the apparatus into a thermostated bath set to a few degrees above room temperature (if available, but this is not mandatory). You could also place the growing apparatus inside a styrofoam or picnic cooler.

Also, for the seed crystal to grow, it is absolutely necessary that the solution never be unsaturated at the temperature of the experiment (usually the room temperature).

Getting Started

1. Carefully suspend your seed crystal from the stick into the supersaturated solution, being careful not to let the crystal touch the bottom of the container.
2. Cover the container in which the crystal is growing. This is to:
 - keep out dust, and
 - reduce temperature fluctuations.

This can be done with plastic wrap or aluminum foil. If you want to allow the solvent (typically water) to evaporate (see step #4a below), then use porous paper (e.g., filter paper).

3. Observe the crystal growth. Depending upon the substance, the degree of supersaturation and the temperature, this may take several days before the growth slows down and stops. A couple of different things can happen at this stage. The questions and answers below can help you.

- Why does the crystal stop growing?
A crystal will only grow when the surrounding solution is supersaturated with solute. When the solution is exactly saturated, no more material will be deposited on the crystal. (This may not be entirely true. Some may be deposited, however an equal amount will leave the crystal surface to go back into solution. We call this an equilibrium condition.)

- Why did my crystal shrink/disappear?
If your crystal shrank or disappeared, it was because the surrounding solution became unsaturated and the crystal material went back into solution. Unsaturations may occur when the temperature of a saturated solution increases, even by only a few degrees, depending upon the solute. (This is why temperature control is so important.)
- How do I get crystal growth restarted? Step 4 below will give you the details.

4. Resupersaturate the solution. This may need to be done on a daily basis, especially when the crystal gets larger. But first, remove the crystal.

1. One way to resupersaturate the solution is to reduce the amount of solvent. This may be done by heating the solution for a while and then cool it to the original temperature. Or, you can just let the solvent evaporate from the solution (this may be a slow process, but has the advantage of getting a better quality crystal.)
2. One can also supersaturate the solution by warming it somewhat, then adding and dissolving more solute, and finally cooling it.

5. Each time the solution is saturated, it is a good idea to 'clean' the monocrystal surface, by

- making sure the crystal is dry;
- not touching the crystal with your fingers (hold only by the suspending line if possible);
- removing any 'bumps' on the surface due to extra growth;
- removing any small crystals from the line.

It is a good habit to clean your hands after each manipulation.

6. Resuspend the crystal back into the newly supersaturated solution.

7. Repeat steps 4-6 as needed.

8. To get improved symmetry and size, slowly rotate the growing monocrystal (1 to 4 rotations per day). An electric motor with 1 to 4 daily rotations might be difficult to find (consider one from an old humidity drum-register or other apparatus). This option becomes useful only when a monocrystal gets rather big.

How Are the Crystals Judged?

Judging Criteria (as used in Canada)

One single crystal will be judged only on the basis of quality as outlined below. The other single crystal will be judged on the basis of combining mass and quality factors as outlined below.

The quality is judged by experts who will rank the crystals on a scale of 0 to 10. A score of 10 will be given to a perfect gem-quality crystal that fits the ideal crystal structure known for the chemical.

1. The crystal is weighed, and the mass M recorded. The crystal must be a minimum of 0.5 g to be eligible for judging.
2. The quality of the crystal is judged on a scale of 1 to 10, with 10 representing a perfect crystal.

The following factors will be considered in judging quality:

- match/mismatch with crystal type (out of 2)
- presence/absence of occlusions (out of 2)
- intact/broken edges (out of 2)
- well formed/misformed faces (out of 2)
- clarity/muddiness (out of 2)

Total Observed Quality $Q_o = x.xx$ (out of 10)

3. The Total Score is then determined as follows:

$$\text{Total Score} = [\log (M_o + 1)] \times Q_o$$

The logarithm of the mass is chosen so that large poor quality crystals don't swamp out smaller good quality crystals.

The value 1 is added to the mass so that crystals weighing less than 1 g get a positive score.