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The 2025 National Crystal Growing Competition Handbook

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Table of Content

A WORD ABOUT OUR SPONSORS 2

INFORMATION ON THE NATIONAL CRYSTAL GROWING COMPETITION 3

What is the Chemical Institute of Canada? 3
How does this competition work? 3
What can I win? 3
Who can participate? 3
Whom am I up against? 3
Competition schedule 4
How do I sign up? 4

IMPORTANT CONTACTS FOR THE CRYSTAL GROWING COMPETITION 5

To order your material: 5
How does the competition work? 6
How and when are the crystals judged? 7
National Judging Criteria 7

GUIDE TO CRYSTAL GROWTH 7

First, what is a crystal? 7
Recrystallization 8
Which substances crystallize well? 9
Precautions when manipulating chemical substances 10
How to grow crystals 11
What you need to know before starting 12
First step: growing a seed crystal 12
What you will need 12
What you should do 12
Second step: Preparation of a supersaturated solution 13
What you will need 13
Method One 13
Method Two 14
Method Three 14
Third step: Growth of a large crystal 14
What you will need 15
What you should do 15

A word about our sponsors

These scientific companies, and this association, have generously accepted to sponsor this competition. Without them, this competition would not be possible! They all share a common passion for science, and in most cases, specifically for crystals. Here are their main interests:

70 1955-2025	The Mineralogical Association of Canada (MAC) was formed in 1955 as a non-profit scientific organization to promote and advance the knowledge of mineralogy and the allied disciplines of crystallography, petrology, geochemistry and mineral deposits. MAC has a commitment to further public awareness of mineral sciences and is proud to sponsor the NCGC.
CCDC advancing structural science	The Cambridge Crystallographic Data Centre (CCDC) are world-leading experts in structural chemistry data, software and knowledge for materials and life sciences research and development. The CCDC software suite allows for searching and structure or arrangement of elements, and seeing quickly if anyone has submitted a crystal with that structural feature before.
boreal science	For over 55 years, Boreal Science has proudly served educators throughout Canada with the best in science supplies and service. From microscopes and models to probeware and physics, Boreal Science offers high quality materials for teaching science in the classroom and lab. A reputation of dependability and a focus on meeting the unique needs of Canadians have earned Boreal Science the honour of being Canada's most trusted science education supplier. Striving to consistently bring you the best, Boreal Science offers you a variety of value-added conveniences.
SolidStatePharma®	Solid State Pharma is a Halifax based pharmaceutical research company with speciality in crystallization engineering and solid-state science. As a partner to global pharmaceutical companies, SSPI combines rigorous experimentation with insightful analysis to generate knowledge, not just data.
PROTO X-RAY DIFFRACTION	Proto is a leading provider of portable and laboratory-based x-ray diffraction (XRD) systems for the characterization of materials. Proto's product lines include powder diffractometers, residual stress and retained austenite measurement systems, Laue single-crystal orientation systems, x-ray tubes, and custom XRD systems. We are also pleased to offer measurement services through our American and Canadian laboratory locations, which are ISO/IEC 17025:2017 accredited.
BRUKER	Detailed insight into the relationship between structure, function, and reactivity is crucial for the success of modern science. Single Crystal X-ray Diffraction is one of the most powerful methods for generating this vital information and has thus become an essential tool for new discovery. Bruker is proud to make state-of-the-art XRD instruments.

Information on the National Crystal Growing Competition

What is the Chemical Institute of Canada?

The Chemical Institute of Canada (CIC) is a Canadian, not-for-profit association of professionals involved in the field of chemistry, chemical engineering and chemical technology. The CIC association organizes outreach activities promoting chemistry to students and the public. The National Crystal Growing Competition, which has been going on for more than thirty years, is one of these.

How does this competition work?

The competition aims at growing the largest and highest quality crystal possible. It takes place in Canadian schools during the school year. Winning crystals from each school are sent for evaluation, first to a regional coordinator, and regional coordinators judge the crystals they receive, sending up to two student samples and one teacher/technician samples for National Judging. Of the two student samples sent, one is deemed the regional winner. Nationally, crystals from all regional coordinators are ranked for three categories: Best Overall Crystal, Best Quality Crystal, and Best Teacher Sample.

What can I win?

Students and their teachers can win cash prizes and will receive individual certificates for the prizes. Prizes will be posted on the Competition web site closer to the competition growth period and will be based on the generous donations of our sponsors and supporting grants.

In the coming years, efforts are being made to expand the scope and impact of the prizes, including more than just monetary prizes, ideally not exclusively at the National level. Discussions are underway with current and new sponsors relating to this intent.

Who can participate?

All Canadian high school students or homeschooled youth between the ages of 13 and 18 (included) can participate. Students can participate individually or as teams of 2. There are no fixed limits to the number of participants per school but be mindful that teams will share any prize money earned evenly. The competition is also open, although in a separate division, for school teachers and lab technicians.

Whom am I up against?

Participants are assigned to the following four divisions:

- Division 1: School students within regions that have coordinators. Crystals are submitted to the regional coordinator for regional judging.
- Division 2: “Outlier” school students are those living outside regions with coordinators. These crystals are submitted to the national coordinator for “regional” judging.
- Division 3: Home-schooled students. These crystals are submitted to the national coordinator for “regional” judging.
- Division 4: High school teachers. Regional coordinators select the best teacher sample overall for their region, sending it Nationally for judging, separate from student crystals.

Winning crystals in each regional section of Divisions 1, 2, and 3 are pooled against one another for the final, national judging in their defined Best Overall or Best Quality categories.

Competition schedule

The 2025-2026 competition schedule appears below. ***Please note that these dates are considerably different to the usual schedule as I test different approaches to the competition processes.*** In case of abnormal delivery delay of the substance to be crystallized, please contact your regional coordinator, who will adjust dates if required.

September to December	Competition announcements and information packages shared with teachers, high schools, and school boards by regional coordinators. Updates are made to the website in this time.
September to February	Schools register with their regional coordinator
September to February	Schools order/purchase their chemicals
Sept. 17th to Mar. 18th	Crystal growth will occur. Teachers can select a four-week period where they, and their students, will grow the crystal, beginning no later than February 11th. The only reason a teacher and students should start growing between February 11th-18th is due to unexpected delays in receiving the chemical to be grown. If this happens, **please alert the National Coordinator ASAP.** → **The chosen growing duration must not exceed 4 weeks!**
By March 27th	Schools send their best two student crystals (and the teachers crystal) to the nearest regional coordinator (total 3 samples sent per teacher).
By April 24th	Regional coordinators judge the samples they receive by April 20th. Judges will send their two winning student crystals for Best Overall and Best Quality crystals, along with the best regional teacher crystal, to the national judging team at the Canadian Light Source (CLS) by April 24th. Of the two student samples, the Regional Coordinator will select the best to be the Regional Winner. All prize alerts will be sent out following National Judging. **At this point, Regional Coordinators should alert the relevant teachers of student samples sent for National Judging, asking them to seek consent from parents to share an e-mail address that potential Regional or National prize award money via e-transfer to, along with any final award certificates.**
May 1st to 22nd	National judging occurs, with alerts made to teachers of due award recipients by the National Coordinator in the first week of June. Prizes will then be sent asap upon receiving emails to e-transfer.

How do I sign up?

The first key step to signing up is filling in the following Google Form: https://docs.google.com/forms/d/1f8uQvJhZfTsJc22RUi77Fwrwa89IxY10eDYKVRmx3K0/edit?pli=1

Afterwards, the second key step is to contact your regional coordinator to let them know that you are participating so they are aware. If you are unsure of who your coordinator is, please reference the “Important Contacts for the Crystal Growing Competition” table below and find the nearest coordinator. If multiple coordinators are in your area, check which host institution is closer via Google Maps. If you still can't tell, contact the national coordinator: CrystalGrowingCompetition@gmail.com. **Please do not overlook these two key steps, they allow regional coordinators to organize and contact participants when needed.**

Important Contacts for the Crystal Growing Competition

Role	Name	Province or Territory	Institution	Email
National Coordinator	Tanner George	Nova Scotia **Regions include:** PEI, MB, YT, NU, NWT, and home school.	Dalhousie and Saint Mary's University	CrystalGrowingCompetition@Gmail.com
Regional Coordinator	Ian Phillips	Alberta - Edmonton	University of Alberta	driang.phillips@gmail.com
Regional Coordinator	Mike DiPietro	British Columbia - Vancouver	Southridge School	mdipietro@southridge.bc.ca
Regional Coordinator	Tasha Jarisz	British Columbia - Vancouver Island	University of Victoria	tjarisz@uvic.ca
Regional Coordinator	Frank Schaper (Hein)	Quebec - Montreal	Universite de Montreal	Frank.Schaper@umontreal.ca
Regional Coordinator	Nicholas Ryan	Newfoundland	Memorial University of Newfoundland	nickryan@mun.ca
Regional Coordinator	Gayle Hanlon	Ontario - Niagara	AGATE Private School	info@learnfree.ca
Regional Coordinator	Barbara Blackwell and Indira Thapa	Ontario	Agriculture and Agri-Food Canada	Barbara.Blackwell@agr.gc.ca and Indira.Thapa@agr.gc.ca
Regional Coordinator	Jordan Bentley	Ontario - Toronto	University of Western Ontario	jordan.bentley000@gmail.com
Regional Coordinator	Abdelaziz Nait Aijou	New Brunswick	Universite de Moncton	Abdelaziz.nait.ajjou@umoncton.ca
Regional Coordinator	Amitabh Jha	Nova Scotia	Acadia University	Amitabh.jha@acadiau.ca
Regional Coordinator	Nicholas Vukotic	Ontario - Windsor	University of Windsor	nvukotic@uwindsor.ca
Regional Coordinator	Andrew Chan	Saskatchewan	University of Regina	Andrew.Chan@uregina.ca
Regional Coordinators	Guillaume Bélanger-Chabot et Rafael Pérez	Québec - Québec	Laval University	cristaux@chm.ulaval.ca

To order your material:

In 2025-2026, the crystals will be grown from **aluminum potassium sulfate dodecahydrate. Contact Boreal Science by phone at 1-800-387-9393,** by fax at 1-800-668-9106, or by e-mail at scied_boreal_main@avantorsciences.com, between September 19th and January 7th. When ordering use **quote number 8602918950–item No. 470300-154 (for 500g) or No. 470300-152 (for 2500g),** aluminum potassium sulfate 12-hydrate. The company will ship one 500 g or 2500 g bottle of the material directly to you with a 15% discount. The discounted price is $20.61 for 500 g or $74.88 for 2500 g, plus a hazardous goods cherge of $17.50, plus shipping charges will vary according to your location, and plus taxes. Schools which already have a contract with Boreal will of course be charged the lowest cost possible. Payment must be made by credit card (a personal credit card can be used if requested), and the **shipping address must be that of the school.** Please allow 7 to 10 business days for delivery once the order has been processed. <u>It is therefore important to order early.</u>

- If you need more material, you can order one extra bottle at the same time. Quantity is limited due to the supply available. Of course, you may purchase supplies from alternative sources.
- Home schooled students must ask their parents to contact a school for ordering the chemical, as shipping can only be made to a school. Alternatively, parents can buy the chemical from a different supplier. Please contact the national coordinator for more information.

<u>How does the competition work?</u>

Crystal growing must begin between Sept. 17th and February 11th, lasting for four weeks (28 days) at the discretion of teachers working with students to participate. Two main rules apply:

- RULE 1: Participating crystals must weigh between 0.50 g to 100.00 g. This corresponds to the use of a maximum of 100.0 g chemicals per student or pair of 2.
- RULE 2: So that all students across the country have equal preparation time, crystal production must be maintained only within the growth period of four weeks. We trust that participants will honor this request, and hope that the added flexibility that is new this year allows for greater incorporation into unique curriculum across Canada.

  As soon as the growth period is finished, teachers should select the two best crystals that will represent the school at the regional level for both Best Overall and Best Quality crystals and send these to the regional coordinator along with their own crystal.

1) The best quality crystal, notwithstanding size (minimum mass must nevertheless be 0.5 g)
2) The best overall crystal, which combines a large size to a good quality (single crystal, well-formed, sharp edges, faces, good transparency, etc.), which must not have a mass higher than 100.0 g.

Each of these two crystals should be well dried and placed in a small plastic bag (Ziploc or similar) labelled with: **1. The first name of students having grown the crystal, 2. the name of the participating school, and 3. the name and email of the teacher to contact if the students win (or more ideally, seek parental consent to share the ideal email for award e-transfer and certificates and include this).**

<u>Clearly label which crystal is a teacher sample, and which is submitted for Best Overall Crystal or Best Quality Crystal. If this is not done, the Regional Coordinator will assign these to the best of their ability.</u>

We know that several crystals from a school may be of roughly equivalent overall quality, and it is sometimes difficult for the teacher to make a choice. In such a case, it may be necessary to submit 3 student crystals. Of these crystals from a given school, only two will be the “official” crystals to be considered for all prize(s) awarded. Please, if this is the case for your students, indicate which category each crystal should be considered for.

How and when are the crystals judged?

See schedule for judging timelines Regionally and Nationally. Prizes will be attributed to the students having submitted the best crystals. Results will be announced asap, ideally prior to the end of the school year in June.

National Judging Criteria

In past years, a specific formula was used to judge samples, and with the judging role being shifted to a new team in the last year, they have proposed a modified judging outline.

In general, there will be a given number of submissions, and a given number of awards given out. Assuming there are 30 samples split evenly into the best overall and best quality categories, and a top 3 for each, judges will rank the top 10 samples in each gategory. These rankings will then be tallied, and points assigned accordingly. 1st place will receive 10 points, and 10th place will receive 1 point. If a crystal has, for example, been assigned 1st place by 6 judges, 2nd by 4 judges, 3rd by 1 judge, and 7th by 1 judge, they would thus earn 6*10 + 4*9 + 1*8 + 1*4 = 108 points. Crystals will then be ranked based on these scores, and the lead judge from the CLS will raise any concerns about rankings to the team of judges. This would mean that if the Best Overall Crystal 3rd place crystal had a higher score, but could be argued that the 4th place is truly better in a 1v1 comparison, they would be swapped if judges agree with this determination.

With the shift from judging being a duty of the National Coordinator to now having crystals ranked by *many* more judged (38 last round!), this streamlined ranking will help receive input from more qualified experts in crystallography, without getting bogged down in subtle differences in numeric scoring. If a decision truly cannot be made between two crystal samples for a given prize, the heavier of the two will be arbitrarily chosen, **or** the crystals will be deemed to have had a tie.

Guide to crystal growth

First, what is a crystal?

A crystal is a solid that consists of the various atoms, ions, or molecules organized in a uniform repeating pattern. This results in the material having a specific shape, colour, hardness, lustre, and having characteristics such as magnetic, optical, electronic, mechanical, or other properties, based on what and how the elements are arranged in the crystal. Diamond (used in jewelry 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 substances that can form crystals. In medicine, crystals can be engineered to be specific shapes, sizes, and mixtures of compounds which can greatly improve or impart desirable pharmaceutical properties like high or low solubility as needed, controlled dissolution rate, and synergistic effects. Crystals, and the many science disciplines reliant on their applied use, are made possible by understand what it means for a given material to be crystalline.

Crystals are also found within technology such as hardware components where they play key roles such as capacitors (lithium fluoride), resistors (ceramics), conductors (thinly plated gold crystals, polycrystalline copper wires), photo active layers in solar cells (silicon, lead iodide perovskites), light detectors (germanium telluride for X-ray detection), in light emitting materials (gallium nitride = blue light in LEDs, nickel chromium alloy used to generate infrared radiation (and cook toast)), and many more. To understand why these specific elements, find their way into crystals whose shape and size imparts their properties and thus function is to be a chemist, physicist, geologist, structural biologist, and many more science careers. Industry is largely built on the understanding and utilization of crystals across every field of modernity, encompassing agricultural through fertilizers, technology through most hardware, health through vitamins and medicines, art through dyes and pigments, and contruction through many of the materials used.

Recrystallization

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. Click on these links for more detailed information:

Buffalo University videos used for the American crystal growing competition:

1) https://www.youtube.com/watch?v=gsC039jpOT0

2) https://www.youtube.com/watch?v=_0F0I3XKiOY

University of Otago, NZ:

https://www.otago.ac.nz/chemistry/outreach/crystals/growing/index.html

Web site of the international Union of Crystallography competition held in 2014:

https://www.iycr2014.org/participate/crystal-growing-competition-2014/info-for-newcomers/how-to-grow

Instructables workshop:

https://www.instructables.com/How-to-grow-great-crystals/

CrytalVerse Youtube channel for high quality growth tutorials:

https://www.youtube.com/channel/UCbLvU2Gj9bNG0kusKw-tbfQ

CrystalVerse website for more detailed instructions and demonstrations/tutorials:

https://crystalverse.com/

Figure 1. Example of some of the incredible tutorials available at crystalverse by Chase Lean. These crystals of sodium chloride (table salt, NaCl) are grown following a specific procedure which allows for isolation of these pyramid structured crystals.

Which substances crystallize well?

Many substances crystallize. At home, table salt (sodium chloride) is often used to grow crystals. For the competition, we change the chemical used each year. Thus far, the National Crystal Growing Competition has used three different substances:

- Cupric sulfate pentahydrate (copper (II) sulfate pentahydrate, or “bluestone”), which was used in 2022.
- Aluminum potassium sulfate dodecahydrate (or “alum”).
- Potassium sodium tartrate (or “Rochelle Salt”).
- Potassium chloride, the crystal grown in 2024-2025.
- An endless variety of novel crystalline solids being made in academic synthetic chemistry research labs (organometallic compounds, new types of salts, and novel organic compounds).

The first two chemicals are available from most laboratory chemical supply houses. The third may be bought at a grocery store, but make sure to use real cream of tartar to do your experiment, as some sellers substitute a blend of two different chemicals. Potassium chloride can also be found as a sodium free salt substitute in grocery stores; however, this contains impurities such as anti-caking agents which may impact crystal growth.

Other chemicals that give good crystals include:

- Potassium ferricyanide,
- Sugar,
- Magnesium sulfate heptahydrate,
- Copper acetate monohydrate, and
- Calcium copper acetate hexahydrate.

<u>Precautions when manipulating chemical substances</u>

Table 1. Safety information for recently used crystal growing substances.

Chemical	Pictogram and signal word	Classification	Hazard statements	Precautionary statements
$CuSO_4$ $\cdot 5H_20$	 Warning	- Acute oral toxicity - cat. 4 - Serious eye damage eye irritation cat. 2	- Harmful if swallowed - Causes serious eye irritation	▪ Wash hands thoroughly after handling ▪ Do not eat, drink or smoke when using this product. ▪ IF SWALLOWED: Call a POISON CENTER or a doctor if you feel unwell ▪ Rinse mouth ▪ Dispose of contents/containers in accordance with local regulations ▪ Wear eye protection ▪ IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing ▪ If eye irritation persists: Get medical advice/attention.
Alum	 Warning	- Serious eye damage/eye irritation cat. 2	- Causes serious eye irritation	▪ Wash hands thoroughly after handling ▪ Wear eye protection ▪ IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing ▪ If eye irritation persists: Get medical attention.
Potassium Chloride	Potassium chloride is not a hazardous substance. Avoid contact with eyes, and ingestion of the material in large amounts.			

Substances chosen for the competition are not very dangerous. Precautions are nevertheless needed. In high schools, crystal growth will probably be undertaken in a laboratory, and wearing a lab coat and safety glasses will be mandatory, as will be washing your hands after manipulating these substances.

If growing crystals at home, wearing an overall or an apron is advised, and wearing safety glasses, which are readily available in hardware shops, is strongly suggested. Again, you should wash your hands after using the substance.

In all cases, if you get some solid or solution in your eyes, thoroughly wash your eyes with room temperature tap water for 5 to 15 minutes. If your eye remains irritated, consult your doctor or local hospital immediately. In such an event, it is strongly advised to bring the Safety Datasheet supplied by Boreal (https://www.boreal.com/assetsvc/asset/en_CA/id/10607448/contents).

Chemicals used in this contest are listed in the Workplace Hazardous Materials Information System WHIMS-1985 system. Safety information is given in the Safety Data Sheet that the chemical supplier normally includes with the product. According to the Répertoire toxicologique of the CNESST (https://reptox.cnesst.gouv.qc.ca/en/Pages/to-english-users.aspx), the following safety information for these follows in Table 1.

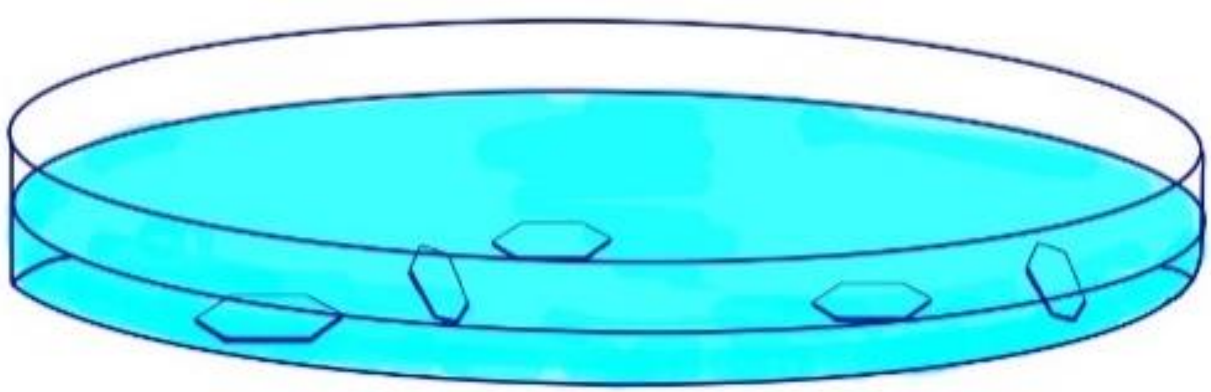
When manipulating chemicals, is it essential to always thoroughly wash your hands with soap and water afterwards. The key hazards for chemicals used in the National Crystal Growing Competition are listed below.

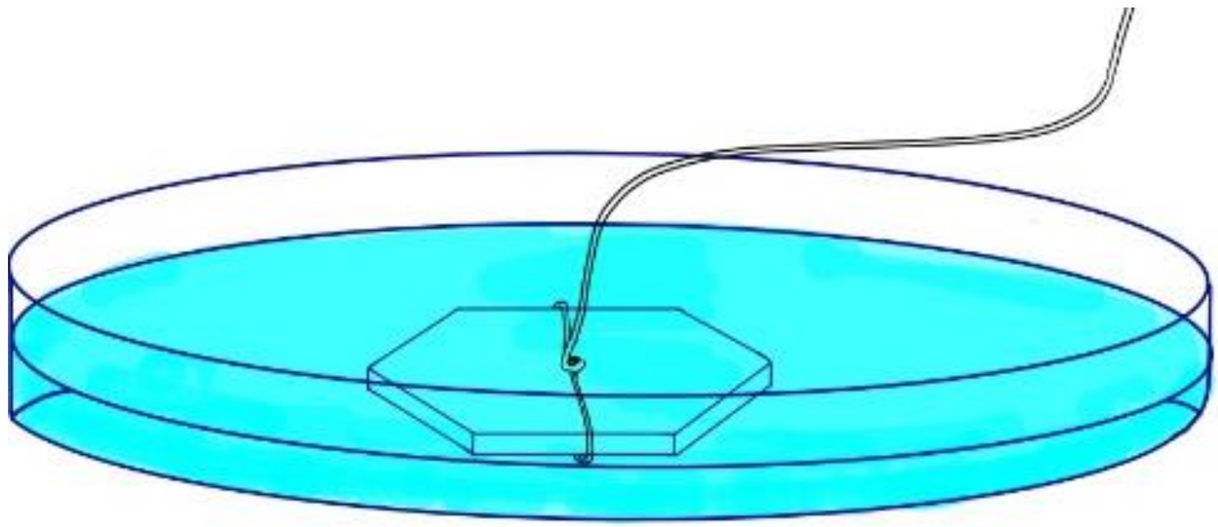
How to grow crystals

To obtain large single crystals, three steps are usually followed:

1) A small seed crystal is obtained
2) A supersaturated solution is prepared
3) Increasing the size of the seed crystal is performed by suspending this seed crystal into the supersaturated solution (more details later).

It is relatively easy to obtain nice small crystals. Obtaining larger, almost perfect crystals is almost an art, and requires constant attention to details. The rest of this guide will teach you the basics of this art.





What you need to know before starting

- 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 the Handbook of Chemistry and Physics, section Aqueous Solubility of Inorganic Compounds in Mass % as a Function of Temperature.*

First step: growing a seed crystal

The aim of the competition is to obtain a single crystal and not a bunch of crystals all stuck together and intergrown, no matter how nice this may look. In order to do this, you will need a small, well-formed crystal, which will serve a "seed" to start crystal growth. You will then let this small crystal slowly grow bigger, as a rapid crystallization often leads to multiple crystals instead of a single, well-formed crystal.

What you will need

- Substance to be crystallized;
- Distilled or demineralized water;
- A shallow dish (e.g., Petri);
- Heating plate or stove;
- Beaker or other small container, 100 to 250 mL capacity
- Fishing line (1 to 2 kg strength);
- Small stick (popsicle sticks work fine)
- A magnifying glass (optional).

What you should do

- Warm about 50 mL (1/4 cup) of water in a glass container.
- Dissolve enough of the substance to produce a saturated solution at 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 magnifying glass, select a regular, small transparent crystal. This will be your seed crystal.
- Tie the seed crystal with the fishing line by using a simple overhand knot. Make sure the line is long enough (approximately half of the height of the beaker used in Step 3).
- Suspend the seed crystal in a shallow dish (1 to 2 mm deep) containing a small amount of supersaturated solution (a few milliliters, see next section for how to prepare the solution) in a shallow container, for example a Petri dish for some time (1 to 2 days).
- Check with the magnifier that the seedling crystal is well attached to the line, and that the crystal grows over the line. 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.

<u>Second step: Preparation of a supersaturated solution</u>

To grow a large crystal, you will need to suspend it in a supersaturated solution. This solution is not in an equilibrium state: you want it to contain more of the crystallizing substance (the solute) than normally presented. In order to do this; you will first prepare a saturated solution, which is at equilibrium and which contains the maximum of the substance that can dissolve in water. Afterwards, you will change the conditions in order for the substance to be too concentrated as compared to equilibrium conditions and the solute will need to crystallize out. This, however, takes time, and meanwhile, your solution is supersaturated! Many methods exist to obtain a supersaturated solution. We have given below three different methods.

Please note: Quantities of the growing substance and of water depend on solubility at room temperature and at a slightly higher temperature. Handbook data will guide you, but you may also need to proceed by trial and error to determine the exact proportions, just like any scientist would do when beginning a new experiment.

<u>What you will need</u>

- Substance to be crystallized;
- Distilled or demineralized water;
- Thermometer;
- Scale;
- Heat-resistant glass or stainless steel container (1 L or more);
- Heating plate;

<u>Method One</u>

- 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.
- Stir the mixture until it appears that no more will go into solution.
- Continue gently stirring the mixture while slowly heating it.

- Once all of the substance has gone into the solution, remove the container from the heat.
- Allow the solution to cool to room temperature.

You now have a supersaturated solution.

Note: The supersaturation method, as well as the second one, works when the solute is more soluble in hot solvent than cold. This is usually the case, but there are exceptions. For example, the solubility of table salt (sodium chloride) is about the same whether the water is hot or cold. Some substances are even more soluble at low than at high temperatures.

Method Two

- Select an appropriate volume of water.
- Warm this water to about 15–20° above room temperature.
- Add some of your substance to the warm water and stir the mixture to dissolve completely.
- Continue adding the substance and stirring until there is a slight amount of material that won't dissolve (the solution will be slightly cloudy).
- Warm the mixture a bit more until the remaining material goes into solution. The solution must be entirely transparent, with no haziness whatsoever.
- Once all of the substance has gone into the solution, remove the container from the heat.
- Allow the solution to cool to room temperature.

- You now have a supersaturated solution, one which should be clear. If slightly cloudy, **add a bit of water, reheat and let the solution cool again.**

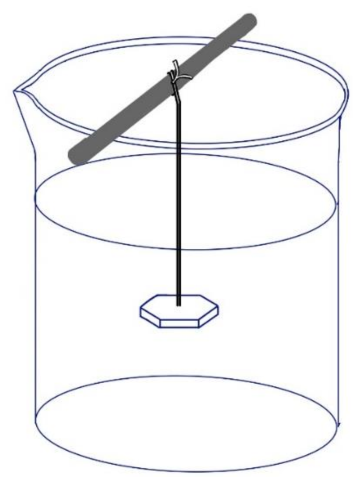
Method Three

- Prepare a saturated solution, using the solubility value (mass of substance / volume of water) found in a chemistry handbook.
- Let the water evaporate (this can take a few hours up to a few days, depending on how well saturated the initial solution is).

This procedure is simple, but slower, and also works with substances which are more soluble at lower temperatures, contrary to the two previous methods.

Third step: Growth of a large crystal

You are now ready for the final growing step. You will suspend your seed crystal in the supersaturated solution prepared in Step 2. This solution contains more than the maximum solubility of the solute, it is not at equilibrium, and the solute will "want" to get out of the solution. It will crystallize onto any surface that can serve as a seed, including your seed crystal (and this is what you want) or any dust particle or solid impurity present (which you want to avoid, as it will give irregular, badly shaped crystals).



The speed at which crystallization occurs will greatly influence final crystal quality. The more supersaturated the solution (the higher the excess in solute as compared to equilibrium conditions), the faster the crystal will grow. However, the best crystals are always obtained with a slow growing speed.

One word of warning: as solubility varies with temperature, it is of utmost importance to avoid temperature fluctuations during crystal growth. Further, your solution must always remain saturated at the chosen growth temperature (usually room temperature), or else your crystal could dissolve partially or entirely. It is good to check with facilities management regarding normal temperature fluctuations in your storage location for growing crystals.

More symmetric crystals can be grown by rotating the crystal in the supersaturated solution slowly. Having such a setup can improve your crystal shape but is not essential.

Unfortunately, many schools have had the disappointment of admiring a big crystal on a Friday, only to come back on Monday to an empty fishing line. The reason? A rise in room temperature in the school over the weekend, which caused the crystal to dissolve completely. The worst period for this is around October when schools turn on the heating systems. For this reason, if available, growing the crystals in a thermostated bath set to a few degrees above room temperature is highly recommended. If unavailable, placing the growth set up inside a cooler (Styrofoam or other) will limit temperature fluctuations, and can also save the day.

<u>What you will need</u>

- Substance to be crystallized;
- Seed crystal of the substance to be crystallized, tied to a fishing line;
- Small wood stick (e.g., Popsicle stick);
- Distilled or demineralized water;
- Thermometer;
- Scale;
- Heating plate or other heating device;
- Beaker of 2 to 4 liters volume;
- Styrofoam picnic cooler (optional);
- Magnifying glass or microscope (optional);
- Thermostated bath (optional);
- Slow revolution motor (1 to 4 rotations per day) (optional).

<u>What you should do</u>

1. Take the fishing line on which you have tied your seeding crystal. Attach to a wooden stick (popsicle stick) at the other end, making sure the crystal will be immersed approximately in the middle of your supersaturated solution in the growing vessel.
2. Carefully suspend your seed crystal from the stick into the supersaturated solution, taking care not to let the crystal touch the bottom of the container.
3. Cover the container in which the crystal is growing. This is to:
   - keep out dust, and
   - reduce temperature fluctuations.

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

4. Observe the crystal growth. Depending upon the substance, the degree of supersaturation, and the temperature, it may take several days before the growth slows down and stops.

- WHY DOES THE CRYSTAL STOP GROWING?

A crystal will only grow when the surrounding solution is supersaturated with the 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 the 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 the solution. Unsaturation 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?

You must re-supersaturate your solution. Refer to steps 5 and 6 for details.

5. Re-supersaturate the solution. This may need to be done on a daily basis, especially when the crystal gets larger. But first, remove the crystal.

    One way to re-supersaturate 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. Alternatively, 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.) You can also supersaturate the solution by warming it somewhat, then adding and dissolving more solute, and finally cooling it.

    Removing the crystal, cleaning as below, and dissolution of the residual solid and filtering into a new vessel may also lead to a supersaturated solution, but losses may material may occur on the filter funnel and paper. Reducing the volume slightly with heat, filtering, and washing with 3 very small portions of water can help prevent losses.

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.

6. Resuspend the crystal back into the newly supersaturated solution.
7. Repeat steps 5 and 6 as needed.
8. To get improved symmetry and size, especially if the crystal gets very big, better results will be obtained if you slowly rotate the growing monocrystal (1 to 4 rotations per day) while it is immersed in the supersaturated solution. An electric motor with 1 to 4 daily rotations might be difficult to find (reusing one from an old humidity drum register or a similar apparatus is suggested).

9. Remove your crystal from the bath once the growth period is finished and wipe it thoroughly with absorbent paper. Do not touch your crystal with your fingers! Once well dried, put your crystal in a small plastic bag (such as a Ziploc bag), close it, and put a label on the bag stating your name and school name, and give the crystal to your teacher or lab technician. They will choose the best two crystals and will send them to the regional coordinator for judging. It is important to verify, before sending any crystal, if their mass falls between the 0.5 to 100 g thresholds for acceptable crystals: if not, the crystals are automatically disqualified.

The teacher or technician should consult sections “Competition schedule”, “How the competition works” and “Judging criteria” for more information on how the crystal are judged, and when and how to send your two selected crystals to the regional coordinator. Before sending your crystals, please do not forget to check that they weigh between 0.5 and 100.0 g. Crystals outside this range will be automatically disqualified.

At this stage, some people varnish their crystals. This ensures that the crystals do not dry out and maintains their general shape longer. This may hide some defects present on the crystal faces, but on the other hand, edges appear rounder, less well-defined. Although we have decided not to disqualify these varnished crystals, these will invariably lose many points due to loss in perfection of the edges and will invariably fall down the ranking. We do not recommend that you varnish the crystals that will be submitted to the competition.

10. Finally, when manipulating chemicals, is it essential to always thoroughly wash your hands with soap and water afterwards.

11. In the event a crystal wins, **ensuring the winner can be contacted and receive their prize is very important**. *Teachers must seek the approval of the parental guardian of participating students to provide necessary informed consent for participants sharing the contact information (email) that will be needed to reach out and award prizes.*