The 2017 Youngstown State University Crystal Growing Competition Handbook

Adapted from The National Crystal Growing Competition by the Chemical Institute of Canada and the University of Wisconsin Handbook.

http://www.cheminst.ca/outreach/crystal-growing-competition

Official Sponsors

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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 color, and having other characteristic properties. 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 crystals.

Re-crystallization 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:

- crystal types
- shapes and sizes
- light and color
- how crystals form

What is the crystal growing contest?

Youngstown State University has launched the 1st annual Youngstown State Crystal Growing Competition among **high** school students to be held March 8th, 2017. High school students will grow crystals of the potassium aluminum sulfate (Alum).
This is an exciting scientific competition as well as a fun, hands-on lab experience. Instructions on how to grow crystals are provided on the web and some hints are given in this handbook.

When does the competition take place?

The competition will take place the week of March 8th at Youngstown State University. For 2017, the crystal growing period is from January 6th to February 23rd. Groups selected to continue to the competition can grow until March 7th.

The deadline for registration will be **February 24th, 2017.**

Who Can Participate?

•All high school students or homeschooled youth ages 13-18.

• Individuals or teams of up to four students. There is a limit of 12 participants per school.

What are the categories?

- Most Perfect Crystal
- Largest Single Crystal
- Artistic Use of Crystal Form
- Gong in 60 seconds
- Biggest Crystal Cluster
- Wild Card Category

*Each category will be judged separately.

How will crystals be judged?

I. Most perfect crystal

Crystal quality is judged by experts who will rank the crystals c a scale of 1- 100 with 100 representing a perfect crystal
A score of 100 will be given to a perfect gem-quality crystal that fits the ideal crystal structure known for the chemical.
The following factors will be considered in judging quality:

Most Perfect Crystal	1-7	8-15	16-20
match/mismatch with crystal type (out of 2)	Mismatch crystal type	Mismatch/Match crystal type	Match crystal type
presence/absence of occlusions (out of 2)	Occlusions (4 or more)	Occlusions (1-3)	No Occlusions
intact/broken edges (out of 2) well formed/misformed faces (out of 2)	Broken edges (4 of more) Misformed faces (4 or more)	Broken edges (1-3) Misformed faces (1-3)	All edges intact All faces well formed
Correct Color for Crystal	Cloud and Contamination	Cloud or Contamination	No Cloud and Contamination
clarity/muddiness (out of 2)	Muddy	Clear with some haze	Clear

II. Largest crystal

Largest Single Crystal	1-17	18-35	36-50
Size	0-50 grams	51-75 grams	76-100 grams
Oclusions, edges,faces, color, clarity	Occlusions. Edges and faces are broken or misformed Color and clarity are off	Some occlusions. Edges and faces ar are broken or misformed Color and clarity are off some	No occlusions. Edges and faces are not broken or misformed Good color and clarity.

III. Artistic Use of Crystal Form

This is broadly defined category that must be a physical grown crystal incorporated in an artistic work.
This may include but not limited visual, architecture, abstract, ceramics, sculptures, conceptual, and textile arts.
Judges will award the prizes based on the following criteria: creativity, aesthetic value, clarity of explanations, and scientific background.
The participants are encouraged to express themselves by growing crystals and by creating art.
Artistic rubric is based on the principals and elements of design.

Artistic use of Crystal form	1-7	8-15	16-20
Color	Lacks use of color theory	Miminali use of color theory	Color theory used correctly
Shape	Lacks use of dimensional areas	Minimal use of dimensional area	Dimensional areas used effectively
Texture	Lacks texture element	Minimal texture element	Successful use of texture element
Space	Lacks use of space	Minimal use of space	Successful use of space
Form	Lacks form	Minimal form	Uses the element of form
Unity	Piece lacks element of unity	Piece has minimal unity	Piece has unity
Balance	Piece lacks balance	Piece has minimal balance	Piece has balance
Scale/proportion	Piece has no scale or proportion	Piece has minimal scale or proportion	Piece has scale and proportion
Similarity and contrast	Piece lacks similarities or contrast	Piece has minimal similarity or contra	Piece has similarity or contrast
Dominance emphasis	Lacks focal point of emphasis	Minimal focal point of emphasis	Strong focal point of emphasis

I V. Gong in 60 Seconds

Gong in 60 Seconds is a student presentation in which students have 60 seconds to convey the science behind their crystal growing competition creation. The gong will sound after 60 seconds. Each presentation will be rated from 1-100 based upon the following sections of the student presentation and report Students competing in all categories of the crystal competition may compete in the Gong in 60 Seconds presentation.

Gong in 60 Seconds	1-7	8-15	16-20
Introduction	inaccurate or incomplete	accurate and adequate	in depth accurate introduction
Goal of Crystal category	not stated clearly	goal simply stated	goal and rationale stated
Materials and Methods	not clearly stated	stated but not in depth	Detailed materials and methods
Data and analysis	inaccurate or unclear	accurate	detailed explanation of data
Conclusion	unclear or inaccurate	adequate	accurate in depth analysis

V. Biggest Crystal Cluster

Crystal quality is judged by experts who will rank the crystals on a scale of 0 to 20, with 100 representing the BEST biggest crystal cluster.

The following factors will be considered while judging crystals:

	1-7	**8-15**	**16-20**
Mass	50-85 grams	86-121 grams	122 grams-above
Number of individual crystals in the cluster	<10	11-24	25 and above
Clarity	Muddy	Clear with some haze	Clear
Match with Crystal type	Mismatch with crystal type	Mismatch/match with crystal type	Match with crystal type
Circumference ***Circumference should be measured around the widest part of the crystal cluster**	1-4 inches	5-9 inches	10 inches and above

V. Wildcard Category

This category provides the students with the freedom of choice for the substance used to grow their crystals. Keep in mind that if Cupper (II) sulfate is being used, it must be either treated with clear nail polish on all surfaces or within potassium alum. Things to consider for the wildcard category:

- May change or enhance the natural colors of the crystal
- May change the natural shape of the crystal
- May grow a crystal within a crystal

Students should use their creativityto achieve an excellent wildcard crystal!

	1-7	8-15	16-20
Color	Cloud AND contamination	Cloud OR contamination	No cloud nor contamination
Clarity	Muddy	Clear with some haze	Clear
Shape	Crystal type not matched Lacks use of dimensional areas	Crystal Type Mismatch/match AND Minimal Use of Dimensional Area	Crystal Type Match AND Dimensional Area used effectively AND
Originality of Composition	No overaly	Overlay attempted	Crystal within a crystal OR some type of overlay
Size	0-50 grams	51-75 grams	76 grams and above

What Materials Can I Use for the Different Categories?

Biggest Single Crystal, Most Perfect Crystal, Artistic Expression, Best Presentation, Best Crystal Cluster

- Aluminum potassium sulfate (or 'alum')

Wild Card – some possibilities include

- Cupric sulfate pentahydrate (copper (II) sulfate pentahydrate, or 'bluestone');
- Potassium sodium tartrate (or 'Rochelle Salt').
- Copper acetate monohydrate

How do I sign up?

1. Read the "How to Grow Crystals" section.
2. Grow crystals.
3. Please register for the contest by filling out an on-line registration form. State your full name, age, your science teacher's full name and contact information, and school name and address. The registration form is found on our website at ysucgc.weebly.com.

What is the crystallization material and how to get it?

For 2017, the material for the crystal growing competition is alum (potassium aluminum sulfate). This material is chosen because it produces large crystals, which are neither too easy nor too difficult to grow. Potassium alum is a naturally occurring mineral found in areas of weathering. Potassium, aluminum, and sulfate are widely found in food and in the human body. Alum is soluble in water and will crystallize in regular octahedra. In hydrated alums, each metal ion is surrounded by six water molecules. When heated the water can be driven off and an amorphous powder remains.

Alum can be purchased at a variety of stores including Walmart. A 5 pound package of alum can be purchased for around $7.00.

What are the Safety Concerns in this Competition?

Alum is relatively safe, but the usual safety precautions should be exercised. Gloves and goggles are recommended.

Materials used for the Artistic Use of Crystal Form will have different precautions based on the chemicals being used. Consult the Safety Data Sheets for specific information.

The Safety Data Sheets for alum is available at the link below. This and other SDS sheets can also be obtained on the Flinn Scientific website.

http://www.flinnsci.com/Documents/SDS/A/AlumPotassiumSul.pdf

What is the Simplest Way to Grow a Crystal?

***Information on other methods is available at the competition website or online.**

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;
- Heating plate
- Fishing line (1 to 2 kg strength);
- A small wood rod (e.g., popsicle stick);
- A magnifying glass (optional).

Important Things to Know

- 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,

What to Do

1. Warm about 50 mL (1/4 cup) of water in a glass container.
2. Dissolve a quantity of the substance to produce a saturated solution at the elevated temperature.
3. Pour the warm solution into a shallow dish.
4. Allow the solution to cool to room temperature.
5. After a day or so, small crystals should begin to form.
6. Remove some of the crystals.
7. With a magnifier select a beautiful and transparent small crystal. This will be your seed crystal.
8. Tie the seed crystal with the fishing line by using a simple overhand knot.
9. 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).
10. 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 colors or shapes.

Recrystallization

In recrystallization, one tries to prepare a solution that is supersaturated with respect to the solute (the material you want to crystallize). There are several ways to do this.

One is to heat the solvent, dissolve as much solute as you can (said to be a "saturated" solution at that temperature), and then let it cool. At this point, all the solute remains in solution, which now contains more solute at that temperature than it normally would (and is said to be "supersaturated"). This situation is somewhat unstable. If you now suspend a solid material in the solution, the "extra" solute will tend to come out of solution and grow around the solid. Particles of dust can cause this to occur. However, this growth will be uncontrolled and should be avoided (thus the recrystallization beaker should be covered). To get controlled growth, a "seed crystal", prepared from the solute should be suspended into the solution.

The rate at which crystallization occurs will affect crystal quality. The more supersaturated a solution is, the faster growth may be. Usually, the best crystals are the ones that grow SLOWLY.

Thus, if you heated the solvent to near the boiling point to get a highly supersaturated solution on cooling back to room temperature, crystals may start to form before the solution had completely cooled. This is where the "art" of science comes into play. One has to experiment a bit to get the right conditions.

• 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. 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?
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 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.)

One can also supersaturate the solution by warming it somewhat, then adding and dissolving more solute, and finally cooling it.

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