



Prize Winner

Crystal Investigation

Year 5-6

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Growing Good Quality Crystals

Report and Log Book

Submitted for

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in

Crystal Investigation

Category

by

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1. Introduction

This report describes an investigation to find out the factors that affect quality of alum crystals. It explains the hypotheses, equipment used to perform this experiment, results, and weekly log.

2. Investigation Hypotheses

I have the following three hypotheses,

1. *Crystals grown in dark and noise free environment has better shape, smooth edges, and clarity.*
2. *Exposure to light affects clarity of the crystal.*
3. *Temperature variations affect shape and size of the crystal*

3. Crystal Growing Method

Slow evaporation method with suspended technique was used to grow crystals. I used a fishing line to tie seed crystal on one end and a pop stick on the other end. I suspended seed crystals in alum mixture.

4. Details of Ingredients and Equipment Used

I grew two crystals in different environments to test my hypotheses and used the following equipment,

Alum (bought from grocery store)

Deionised water

Glass jars

Pot (to boil water)

Weighing scale

Measuring cup

Coffee filters

Fishing line

Card board pieces

Pop sticks

Rubber gloves

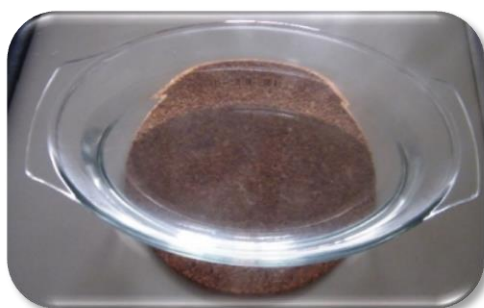
Paper towels

There were other things that I used, like for example, camera, calliper, and thermometer etc. I am not mentioning them here because they do not affect the experiment and were only used to assist with the experiment.

5. Preparation Details

I first weighed 100 grams of alum on the scale and 700 millilitres of deionised water using a measuring cup (I followed Benedict research lab's suggestions about the ratio of alum and water). I rinsed the pot with deionised water to remove any chemicals left on it, because I used the one that we normally use for cooking. I then wiped the pot with paper towels so that it was dry.

I poured water into the pot, turned the stove on and put it on simmering heat level. Once it heat up a little I started pouring the alum powder into the water and stirred the water with an unused disposable plastic spoon. I kept on pouring alum powder and stirring, till the time all the powder was in the water. I left the mixture on the stove and stirred it occasionally. The water was a bit cloudy at first, but when the powder dissolved it started to become clearer. After about 20 minutes the mixture was clear, so I turned the stove off and poured the mixture in a glass dish with flat bottom. I had rinsed the glass dish with deionised water and dried it with paper towels, just like I did with the pot. You can see it in the photo below.



Alum Dissolved in Deionised Water

I left the mixture to cool down and I then put the dish in a kitchen cabinet that was not to be opened by anybody. I left it there for little more than 24 hours. When I took the dish out there were many different crystals at the bottom of the dish. I took out some of the best ones.



I used two coffee filters to filter the mixture two time and poured it in a glass jar and marked the level of the liquid with a marker on the jar. From the seed crystals, I selected the best four and tied them with the fishing line. I was going to use two, the other two were for back up. I wore rubber gloves to tie them, but I can tell you that it was heaps tedious because they kept on slipping from the knot. Both the seed crystals were approximately 4 mm, flat, and hexagonal shaped.



Seed Crystals on the Fishing Line

I tied the other ends of fishing lines with pop sticks and suspended both the crystals in the jar with mixture. I placed this mixture in linen cupboard in the laundry, in a dry, dark and noise free place. I covered the jar with two pieces of cardboard with a little bit of space in between, to ensure that the mixture does not evaporate too fast. Temperature in the cupboard is .5 to 1 C lower than normal room temperature in rest of the house.

I repeated the above-mentioned procedures to make another alum mixture and left it to cool. Just like before, I waited for 6 hours, filtered the mixture, and poured it in another glass jar. Now that I had another jar I took one of the crystals out of the first glass jar and suspended it in the other jar. I covered this jar with pieces of card boards as well, marked the liquid and placed it on the shelf in the open and with exposure to sunlight and at normal room temperature. Both the crystals hung in their respective jars two thirds of the way in the liquid.

In the rest of this document, I will refer to the crystal that grew in the noise free and dark place as **Crystal A**, and the one that grew in open space as **Crystal B**.

6. Duration of the Experiment

I ran this experiment for a little more than 8 weeks. Weekly log and description of the state of crystals, problems encountered, and actions taken are explained in the following pages.

7. Final Output



Crystal A

(Grew in dark and noiseless place with minimum temperature variation)

Size: Length - 30.8 mm, Width - 24.4 mm
Weight: 10 grams



Crystal B



(Grew in normal environment with sunlight and normal temperature variation)

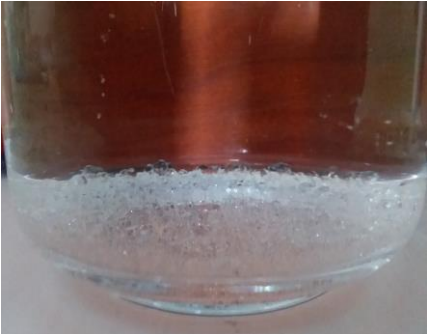


Size: Length – 34.6 mm, Width – 29.3 mm
Weight: 14 grams





8. Conclusions



Upon finishing the experiment, I can conclude that,




- Crystal A** (the crystal that grew in a dark and noise free environment) has much better clarity and regularity than **Crystal B** (the one that grew in the open space). **Crystal B** is cloudy, and its shape is not as good as **Crystal A**. I conclude that **this experiment proves hypothesis 1**. So, growing a crystal in a dark and noiseless environment will result in better clarity, well formed edges, and overall shape.
- Crystal A** shows one thin band, but **Crystal B** has a lot. I conclude that exposure to light affects clarity of the crystal. So, **this experiment proves hypothesis 2**.
- Environment around **Crystal A** was stable and there were no significant variations in temperature. **Crystal B** went through a lot of temperature variations. **Crystal A's** size and weight are less than **Crystal B**, which is heavier and bigger. So, I conclude that **this experiment proves hypothesis 3**.




Date	Description of Inspection (State of Crystals, Problems Encountered and Resolution)	Crystal Characteristics
28/06/2020 (Week 1)	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Crystal A</p> <p>Size: 8.3 mm</p> <p>Temperature: 12.6 °C</p> <p>Shape: Almost pyramid shape on one side, not much on other side</p> <p>Volume: Slight change in mixture level</p> </div> <div style="width: 45%;"> <p>Crystal B</p> <p>Size: 10.5 mm</p> <p>Temperature: 12.9 °C</p> <p>Shape: Both sides have started to develop a pyramid</p> <p>Volume: About 5 mm less than the mark on the jar</p> </div> </div> <p><i>Comments</i> There is difference in the level of mixtures in both jars. Both seed crystals look clear. A few very small grains of crystals have appeared at the bottom of jar A, which is put in the dark place. Jar B has relatively bigger crystals at the bottom, though they are not too many. This week temperature in both places remained in low to mid teens and changed with changes in weather.</p>	<div style="text-align: center;">  <p>A</p>  <p>B</p> </div>



Date	Description of Inspection (State of Crystals, Problems Encountered and Resolution)	Crystal Characteristics
05/07/2020 (Week 2)	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Crystal A</p> <p>Size: 13.3 mm Temperature: 14.8 °C Shape: Full pyramid shape on one side, same shape has started to form on the other side too Volume: Mixture level down by about 5 mm</p> </div> <div style="width: 45%;"> <p>Crystal B</p> <p>Size: 14.9 mm Temperature: 15.7 °C Shape: Starting to become an Octahedron (One corner not fully developed) Volume: More than 7 mm from last week's mark on the jar</p> </div> </div> <p><i>Comments</i> There is a thin layer of crystals at the bottom in jar A. Both crystals are very clear and have smooth faces. In jar B, there were five small crystals (but much bigger than the ones in jar A) at the bottom. There also were some new crystals forming on the fishing line that wiped with a tissue paper. I took crystal B out and filtered the solution using coffee filter and put the crystal back. This helped me take the bottom crystals out of jar B. I have left jar A as it is because I think the crystal layer at the bottom is way too thin to pose any danger to the seed crystal. Like last week temperature in both places remained in low to mid teens.</p> <div style="text-align: center;">  <p>Jar A</p> </div>	<div style="text-align: center;"> <p>A</p>  </div> <div style="text-align: center; margin-top: 20px;"> <p>B</p>  </div>




Date	Description of Inspection (State of Crystals, Problems Encountered and Resolution)	Crystal Characteristics
12/07/2020 (Week 3)	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Crystal A</p> <p>Size: 15.9 mm Temperature: 15.1 °C Shape: Looking like an octahedron Volume: About 4 mm change in the mixture level from last week's level.</p> </div> <div style="width: 45%;"> <p>Crystal B</p> <p>Size: 17.3 mm Temperature: 15.8 °C Shape: Fully formed octahedron Volume: About 10 mm less than the last mark on the jar</p> </div> </div> <p><i>Comments</i> Crystal A is now starting to look like octahedron, improving in regularity, with its faces growing in proportion. It is clear and has smooth faces and sharp edges. Crystal B has developed slight bands on its surface, which are like small lines. I also broke a crystal growing on the fishing line in jar B, just above the seed crystal I can also see white residue on the sides of the jar as the mixture level declines. This means that alum is depositing on the sides, which should have deposited on crystal B. However, Crystal B has smooth faces, sharp edges but slightly slanting shape. Some more crystals have formed at the bottom of jar B too. Temperature has remained steady without major variations.</p> <div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div style="text-align: center;">  <p>Crystal growing on line in Jar B</p> </div> <div style="text-align: center;">  <p>Alum depositing of sides of Jar B</p> </div> </div>	<div style="text-align: center; margin-bottom: 20px;"> <p>A</p>  </div> <div style="text-align: center;"> <p>B</p>  </div>

Date	Description of Inspection (State of Crystals, Problems Encountered and Resolution)	Crystal Characteristics
19/07/2020 (Week 4)	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Crystal A</p> <p>Size: 16.7 mm</p> <p>Temperature: 11.9 °C</p> <p>Shape: Octahedron</p> <p>Volume: About 3-4mm down from last week</p> </div> <div style="width: 45%;"> <p>Crystal B</p> <p>Size: 20.2 mm</p> <p>Temperature: 12.3 °C</p> <p>Shape: Octahedron</p> <p>Volume: 7-8 mm less than the last mark on the jar</p> </div> </div> <p><i>Comments</i></p> <p>Crystal A is a fully formed octahedron and has a balanced shape. However, some strange white thin fluff appeared in jar A this week. I googled to find out what was it, but I did not find an answer. I filtered the mixture twice and dipped the crystal back in it. Crystal A has smooth faces and well-formed edges. On the other hand, Crystal B grew faster. However, I can see some more banding in Crystal B. I have found out from google that this happens when the crystal grows faster. It has affected the clarity of the crystal, through the faces are smooth and the shape is well formed but slightly favouring one side.</p>	<div style="text-align: center;"> <p>A</p>  </div> <div style="text-align: center; margin-top: 20px;"> <p>B</p>  </div>

Date	Description of Inspection (State of Crystals, Problems Encountered and Resolution)	Crystal Characteristics
26/07/2020 (Week 5)	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Crystal A</p> <p><i>Size: 20.5 mm</i></p> <p><i>Temperature: 16.3 °C</i></p> <p><i>Shape: Octahedron</i></p> <p><i>Volume: Mixture level down by 6-7 mm from the last mark</i></p> </div> <div style="width: 45%;"> <p>Crystal B</p> <p><i>Size: 24.6 mm</i></p> <p><i>Temperature: 16.7 °C</i></p> <p><i>Shape: Octahedron</i></p> <p><i>Volume: Reheated the mixture</i></p> </div> </div> <p><i>Comments</i></p> <p>I was concerned about the volume of mixture in jar B and the crystals growing at the bottom, so I reheated the mixture, filtered it and put it back in the jar. I did not add more alum or water to it, which was a little more than half the original amount. So, probably 360 to 380 ml. I watched the mixture closely because I figured out from readings that sometimes the mixture becomes over or under saturated and causes problems, but nothing happened. Both the crystals have grown, but crystal B is growing much faster. It was a relatively warmer week, which is why I think it grew so much. Crystal A is, however, much clearer and has better regularity than crystal B. There are no new changes, except that the bandings have become more noticeable.</p> <div style="text-align: center; margin-top: 20px;">  <p>Jar B</p> </div>	<div style="text-align: center; margin-bottom: 20px;"> <p>A</p>  </div> <div style="text-align: center;"> <p>B</p>  </div>

Date	Description of Inspection (State of Crystals, Problems Encountered and Resolution)	Crystal Characteristics
02/08/2020 (Week 6)	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Crystal A</p> <p><i>Size:</i> 24.4 mm <i>Temperature:</i> 15.7 °C <i>Shape:</i> Octahedron <i>Volume:</i> Mixture level is about 6 mm lower than the last mark</p> </div> <div style="width: 45%;"> <p>Crystal B</p> <p><i>Size:</i> 28.3 mm <i>Temperature:</i> 16.1 °C <i>Shape:</i> Octahedron with one side short <i>Volume:</i> Mixture level is about an inch and a half lower than the last mark.</p> </div> </div> <p><i>Comments</i> What was appearing to be the best week turned out to be disastrous. Crystal B shrunk on one side. It was growing well throughout the week, but on Friday it was left on the shelf when the heater was switched on. I found out about an hour late. The temperature rose to about 25 C. I could not do anything t because I was not home. Now crystal B has a sort of flat corner on one side, which is evident in the photo. This face has become cloudy too. Crystal A has developed banding too, although thin.</p> <div style="text-align: center; margin-top: 20px;">  <p>Crystal B</p> </div>	<div style="text-align: center; margin-bottom: 20px;"> <p>A</p>  </div> <div style="text-align: center;"> <p>B</p>  </div>

Date	Description of Inspection (State of Crystals, Problems Encountered and Resolution)	Crystal Characteristics
09/08/2020 (Week 7)	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Crystal A</p> <p>Size: 27.4 mm Temperature: 15.9 °C Shape: Octahedron Volume: mixture level down by 5-6 mm from the last mark</p> </div> <div style="width: 45%;"> <p>Crystal B</p> <p>Size: 32.5 mm Temperature: 17.3 °C Shape: Octahedron with one side short Volume: 6-7 mm less than the last mark on the jar</p> </div> </div> <p><i>Comments</i> Crystal B grew well this week , gained mass and started improving its shape. The affected corner has filled up a bit, but the crystal's shape has been affected. Banding is still there, though it has stopped growing. I am happy that the variations in the temperature did not results in any changes to the mixture. This also tells me that changes in crystal B occur only because of the temperature and no other factor. On the other hand, Crystal A has been growing steadily, retains its clarity, sharp edges, and better regularity.</p>	<p style="text-align: center; color: red; font-weight: bold;">A</p>  <p style="text-align: center; color: blue; font-weight: bold;">B</p> 

Date	Description of Inspection (State of Crystals, Problems Encountered and Resolution)	Crystal Characteristics
16/08/2020 (Week 8)	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Crystal A</p> <p>Size: 30.8 mm Temperature: 15.3 °C Shape: Octahedron Volume: 4 mm lower than the last mark</p> </div> <div style="width: 45%;"> <p>Crystal B</p> <p>Size: 34.6 mm Temperature: 16.2 °C Shape: Octahedron with one side short Volume: 7 mm less than the last mark on the jar</p> </div> </div> <p><i>Comments</i> Mixture volume in jar has declined a lot and if I lowered the crystal any lower it would touch the floor, so I decided to finish the experiment.</p> <div style="text-align: center; margin-top: 20px;">  </div>	<div style="text-align: center; margin-bottom: 20px;"> <p>A</p>  </div> <div style="text-align: center;"> <p>B</p>  </div>

Acknowledgments

I acknowledge that I was helped by or I consulted the following sources to carry out this experiment,

- Ms. Vira Wallis, our school's Oliphant Science Awards coordinator, who gave me the initial instructional report to carry out this experiment.
- Jason Benedict's you tube videos of Benedict Research Labs, Department of Chemistry, University of Buffalo
 - <https://www.youtube.com/watch?v=NfbbrZcUMCM>
 - <https://www.youtube.com/watch?v=q4xANGKqaYs&t=799s>
- Growing Alum Crystals by David Katz, which can be accessed from the following url, <https://raci.org.au/common/Uploaded%20files/Website%20files/School/crystal/SA%20Crystal%20Growing%20comp/katz%20alum%20crystals.pdf>
- Chemical Institute of Canada's 'The National Crystal Growing Competition Handbook, which can be accessed from https://www.cheminst.ca/wp-content/uploads/2019/09/Discover_Chemistry-NCGC_Handbook_Eng_072019.pdf