



# HOT ICE

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# HOT ICE

I chose to investigate the “hot ice” experiment because I was interested in how a liquid can remain in a liquid state even when it should be a solid, and then crystallize instantly when triggered. In this experiment, a small tap of baking soda acts as a crystal seed to start the reaction. I aim to observe how this small addition affects the speed and completeness of crystal formation. This investigation will help me understand how scientists control chemical reactions and apply these principles in real-life situations such as hand warmers, energy storage systems, and safe industrial processes.



## Question

Does different quantities of baking soda effect the crystal trrigerization?



## Background Information

<https://www.thoughtco.com/definition-of-crystallize-605854>

**Question:** What is crystallization?

**Answer:** Crystallization is the process where atoms or molecules lock together into a very organized, solid shape called a **crystal**. This happens when a liquid or gas cools down or dries up, forcing the tiny particles inside to snap into a specific pattern.

**Website:** ThoughtCo

**Author:** Anne Marie Helmenstine



## Background Information

<https://sciencenotes.org/how-to-grow-a-seed-crystal/>

**Question:** what is a seed crystal?

**Answer:** A **seed crystal** is basically a "starter" piece. It is a tiny, perfect crystal that you use to grow a much bigger one. Instead of the liquid guessing where to grow, the seed crystal gives it a pattern to follow.

**Website:** Science Notes

**Author:** Anne Helmenstine



## Background Information

<http://chemignition.com/blog/sodium-acetate-properties-structure-uses>

**Question**: What is sodium acetate?

**Answer**: Sodium acetate is a white, crystalline powder made by combining vinegar and a sodium source. It comes in two versions: a dry powder or crystals that contain water molecules. It is very useful because it can help keep liquids stable and releases a lot of heat when it turns from a liquid back into a solid.

**Website**: ChemiGnition

**Author**: Kapil Radadiya



# Sources of Information

Title	Website name	Information (web link, publisher, etc)	Year
What is crystallization?	ThoughtCo	<a href="https://www.thoughtco.com/definition-of-crystallize-605854">https://www.thoughtco.com/definition-of-crystallize-605854</a>	Jan/13/2020
what is a seed crystal?	Science Notes	<a href="https://sciencenotes.org/how-to-grow-a-seed-crystal/">https://sciencenotes.org/how-to-grow-a-seed-crystal/</a>	Mar/25/2020
What is sodium acetate?	ChemiGnition	<a href="http://chemignition.com/blog/sodium-acetate-properties-structure-uses">http://chemignition.com/blog/sodium-acetate-properties-structure-uses</a>	Apr/4/2025



# Variables

## Manipulated / Independent Variable

*Independent:* Quantities of baking soda.

## Responding / Dependent Variable

Success of the "instant freeze" reaction.

I will make a success chart to measure the crystallization by observing how the quantities of baking soda affect the formation. Like was it slushy, did it fully crystallized , did only some parts were crystallized or was it still liquid and also checking how much time did each one take to crystallize and was it really hot as the title said ,was it warm or did nothing happened it was normal.



# Variables

## Controlled Variables

- The temperature of the fridge.
- The type of container.
- Quantity of vinegar.



## Hypothesis

By creating a supercooled, supersaturated solution of sodium acetate. With a physical vibration or adding a crystal seed will trigger immediate crystallization. This reaction will cause the temperature of the liquid to rise rapidly as it turns into a solid. Finally, this release of heat proves that the process is an exothermic reaction. In this experiment, I will expect the crystallization to react differently when we add different quantities of baking soda.



# Materials

- **White Vinegar:** 4 Cup per trial.(12 cups)
- **Baking Soda:** 12 TBSP
- **A Stainless Steel Saucepan:** (Don't use an old crusty one).
- **Clear Glass Jars:** To see the magic happen.
- **Coffee Filter:** To keep the "trash" out.



# Procedure

## 1. The Slow Mix

1. Pour 4 cup of vinegar into a large pot.
2. Add 4 tablespoons baking soda **one spoonful at a time**.
  - *Note:* Stir until the fizzing stops.

## 2. The Big Boil

1. Turn the heat to **Medium**.
2. Boil it down until about **90%** of the liquid is gone.
3. **The Goal:** You want about **1/2 cup** of liquid left.
4. **The Sign:** Look for a "crust" forming on the sides of the pan and "lazy," thick bubbles.

## 3. The "Reset"

1. As soon as it looks like thick syrup, turn the heat to **Low**.
2. If it looks "grainy" or like "wet sand," add **one splash of vinegar** and stir until it is 100% clear.
3. **The Drip Test:** Dip a spoon in. If the liquid on the spoon turns into a white crust in the air, it's ready.



# Procedure

## 4. The Chill

1. Pour the clear liquid through a **coffee filter** into a glass jar.
2. **Important:** Do not scrape any yellow/white crust from the pan into the jar!
3. Cover the jar with plastic wrap (to keep dust out).
4. Let it sit on the counter for 20 minutes, then put it in the fridge for 30–60 minutes until **cold**.

## 5. The Magic Trick

1. Take the jar out **very carefully**. No shaking!
2. Take a tiny piece of the crusty stuff left in your pan (this is your "seed").
3. Drop it into the liquid.

## 6. Repeat

1. Do the same thing but with different quantities of baking soda ( 2tbs, 6tbs ).



# Experiment: 4 tbsp

Date:

## Data: (measurements)

Trial 1	Time: 25.78
Trial 2	Time: 26.61
Trial 3	Time: 27.38

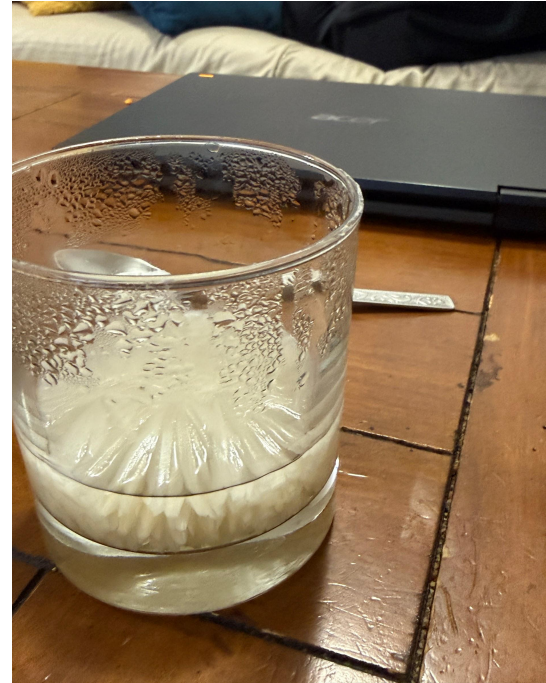
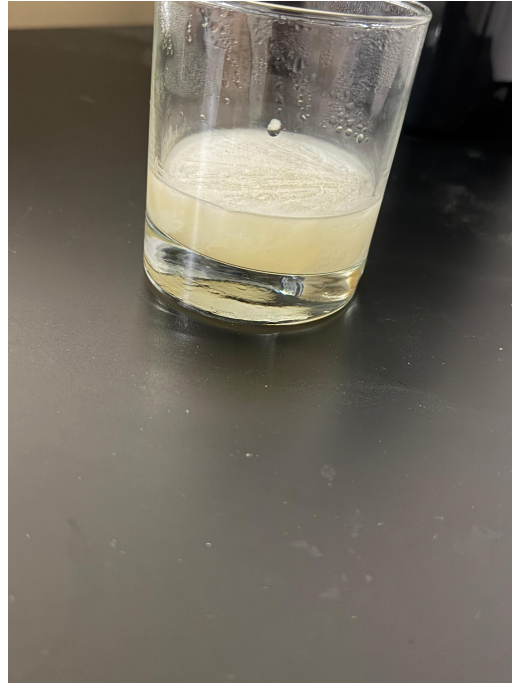
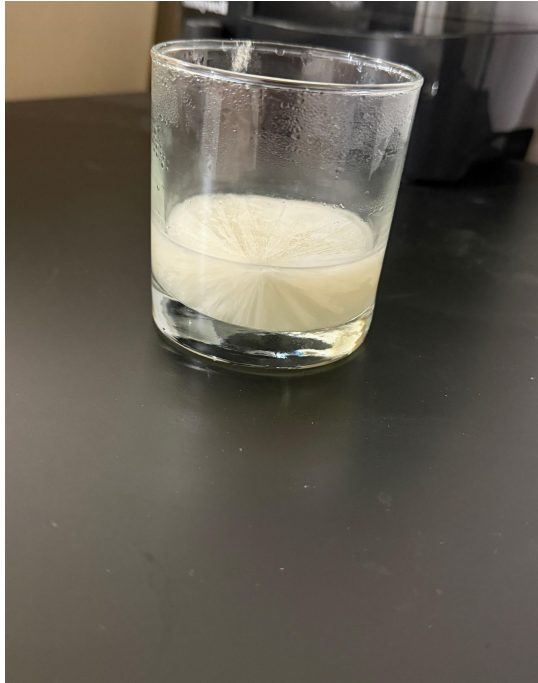
## Observations:/Notes

For my first three trials, the Hot Ice worked perfectly! I used the same recipe every time: **4 tablespoons of baking soda** mixed with **1 liter of vinegar**, then boiled it down until it was a thick syrup. When I triggered the liquid, it turned into solid crystals. It was an exothermic reaction, which means it got really warm, just like those reusable hand warmers you buy at the store. My timing was super consistent, too. Trial 1 took **25.78 seconds** to fully freeze, Trial 2 took **26.61 seconds**, and Trial 3 took **27.38 seconds**. Even though it got a tiny bit slower each time, the experiment was a huge success because it did exactly what it was supposed to do every single time!



# Experiment: 4 tbsp

Photos:





# Experiment: 2 tbsp

Date:

**Data:** (measurements)

Trial 1	Time: 1 min 26 sec
Trial 2	Time: 1 min 23 sec
Trial 2	Time: 1 min 28 sec

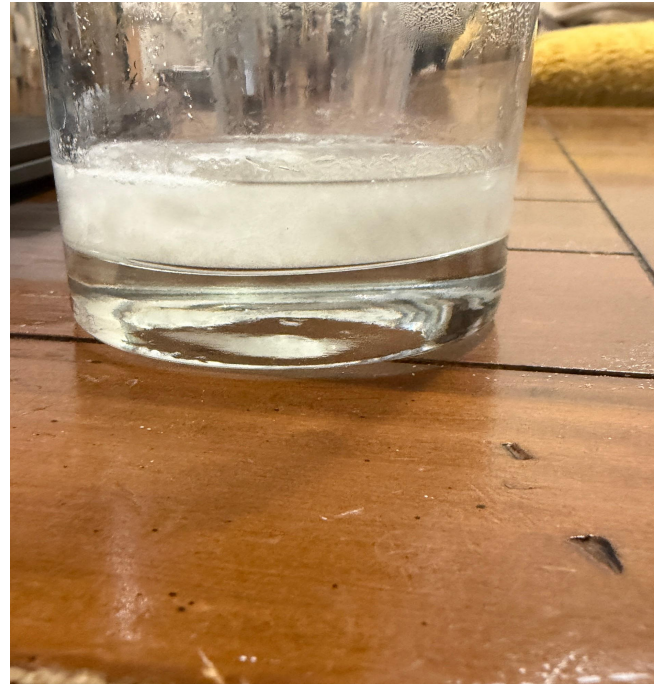
**Observations/Notes:**

Instead of turning into a solid, hot block of ice, the liquid became a slushy and grainy mess. It was much slower, too, taking **1 minute and 26 seconds** (Trial 1), **1 minute and 23 seconds** (Trial 2), and **1 minute and 28 seconds** (Trial 3) to finish. Another big difference was the temperature; while the 4-tablespoon batch got really hot, this weak version just went from cold to normal room temperature. This proves that if you don't have enough baking soda, the reaction isn't strong enough to create a solid crystal or release a lot of heat.



# Experiment: 2 tbsp

Photos:





# Experiment: 6 tbsp

Date:

**Data:** (measurements)

Trial 1	Time: 00 sec
Trial 2	Time: 2 min 12 sec
Trial 3	Time: 2 min 35 sec

**Observations/Notes:**

The final trials used 6 tablespoons of baking soda, creating a highly unstable solution. In Trial 1, the liquid crystallized while cooling, resulting in a time of **0 seconds**. Trials 2 and 3 were much slower, taking **2 minutes and 12 seconds** and **2 minutes and 35 seconds**. Unlike the 4-tablespoon batch, these trials remained **cold** and produced only a grainy texture. This suggests that if the concentration is too high, the solution "crashes" and fails to release exothermic heat.



# Experiment: 6 tbsp

Photos:





## Results: Chart

	Trial 1	Trial 2	Trial 3
4 tbsp of baking soda	Warm like a normal heating pad	Warm like a normal heating pad	Warm like a normal heating pad
2 tbsp of baking soda	From cold to room temperature	From cold to room temperature	From cold to room temperature
6 tbsp of baking soda	Cold	Cold	Cold



## Results: Chart

	Trial 1	Trial 2	Trial 3
4 tbsp of baking soda	It fully crystallized	It fully crystallized	It fully crystallized
2 tbsp of baking soda	<b>slushy</b>	slushy and some parts were grainy	<b>slushy</b>
6 tbsp of baking soda	slushy (it crystallized while it was cooling )	only the parts crystallize where the baking soda was touching	<b>grainy</b>



## Results: Analyze

My results show that the amount of baking soda changes everything about the "Hot Ice" reaction. The **4-tablespoon batch** worked the best because it had the perfect balance of ingredients. This allowed the liquid to turn into a solid block quickly and release a lot of heat. When I used only **2 tablespoons**, there wasn't enough baking soda to build a strong crystal, so it stayed a cold slush. When I used **6 tablespoons**, the liquid was too crowded. This made it "crash" and freeze too early or turn into a grainy mess that stayed cold. This proves that you need the exact right amount of baking soda to make the crystals grow fast and get hot.

# Results: Graph



## Time It Took To Crystallize





# Conclusion

My question was: Does different quantities of baking soda effect the crystal trrigerization?

The answer to my question is: Yes. The quantity of baking soda significantly changes the speed, heat, and texture of the reaction. The **4-tablespoon** mixture was the only one that created a fast, solid, and hot reaction. The 2-tablespoon mixture was too weak and stayed slushy, while the 6-tablespoon mixture was too unstable and "crashed" before it could work properly.

I predicted that different quantities of baking soda would cause the crystallization to react differently. My data showed that the 4-tablespoon batch was the "sweet spot." Using too little (2 tbsp) resulted in a slow, cold slush, and using too much (6 tbsp) caused the solution to become unstable and fail to release heat. This proves that the concentration of the solution is the most important factor in a successful exothermic reaction.



# Applications

Sodium acetate is a phase change material that acts like a reusable chemical battery for heat. It is unique because it can stay as a liquid at room temperature and only releases its stored thermal energy when the crystallization process is triggered. This makes it very useful for creating eco-friendly heating tools that don't need electricity, such as medical heat packs and hand warmers. It is also used in construction to help buildings regulate their temperature and on airport runways as a safe way to melt ice. Because it is non-toxic and biodegradable, sodium acetate is a great way to develop heating systems that are both cheap and safe for the environment.



## Sources of Error

1. Because the heat couldn't reach the top evenly the bottom of the acid was forming the white crust on the bottom even before it was syrupy. That's why we had to take it out before, and the crystal particles were not snapping together to form the crystal because it was too thin and the particles had too much space in between them
2. The amount of the baking soda ( 6tbsp) was too much for 1 litre of vinegar to handle and that's why tiny specks of crystals started to show up and ruined the liquid.



## Extensions

If I were to conduct this experiment again, I would make two major changes to get cleaner data. First, I would use a digital kitchen scale to measure the baking soda in grams instead of using tablespoons. Grams are much more precise, which would help keep the concentrations exact. Second, I would use an indirect heating method, such as placing the glass jar in a pot of simmering water. This would provide a more gentle heat to prevent the liquid from burning or forming "seed crystals" on the sides of the pot.



# Extensions

## 1. The Temperature Test

You could investigate if the starting temperature of the liquid affects how fast the crystals grow. You would keep the baking soda at 4 tablespoons for every trial but put one jar in the fridge, leave one at room temperature, and keep one in a warm water bath. This would show if heat makes the "Hot Ice" reaction move faster or slower.

## 2. Different Types of Vinegar

You could test if the type of acid used changes the crystal structure. Instead of just white distilled vinegar, you could try apple cider vinegar or cleaning vinegar (which has a higher acid percentage). This would help you understand if the purity of the vinegar makes the crystals stronger or more clear.

## 3. The "Seed Crystal" Size

You could experiment with what triggers the reaction. You could compare dropping in one tiny speck of baking soda versus a large "seed" of already-frozen sodium acetate. This would help you see if the size of the trigger changes how the crystals branch out and fill the jar.



# CONGRATULATIONS!!

You have completed your experiment!

Make sure that you enter information from this logbook into the CYSF Digital platform.

You are now ready to create your trifold display and practice your presentation.

