

Designer Ice Cream



Mix up a batch of ice cream and freeze it with an ice bath. Measure the impact of salt in depressing the freezing point of the ice bath.

Engineering Design Process Outline

Step 1: Introduction: Designer Ice Cream

Step 2: Design Challenge

Step 3: Specifications and Constraints

Step 4: Design Criteria

Step 5: Knowledge & Skill Builder

Step 6: Self Quiz

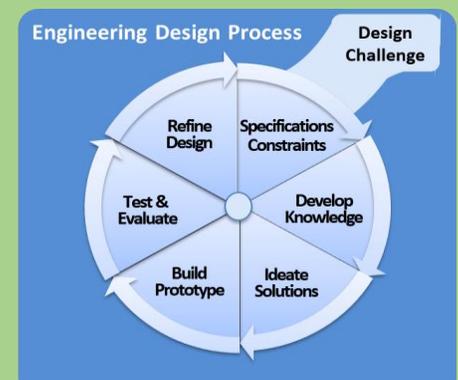
Step 7: Understanding Freezing Point Depression

Step 8: Making Your Ice Cream

Step 9: Test and Evaluate

Step 10: Reflection

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Step 1: Introduction

On a hot summer day, the best thing in the world is ice cream. In this activity, you will be a food chemist that must engineer a process to make ice cream! You will be exploring the best way to chill the ingredients used in ice cream before they become the delicious reward.



Step 2: Design Challenge

You are a food scientist working for the STEM Ice Cream Company. Your job requires you to create the creamiest, coldest ice cream using your food chemistry knowledge. Your ice cream should only use the ingredients provided. You will have to work hard to get it to the right consistency. But be careful, you don't want any of your salt ice bath to contaminate your batch of ice cream!

Materials

Ice Cream*

- One pint of Half and Half
- 1/2 cup Sugar
- 2 Teaspoons Vanilla extract

Ice Bath

- 4 cups ice cubes
- 1/2 cup of salt

EQUIPMENT:

- One 3-quart food container
- Two 1-quart Ziplocs
- Mixing Bowl
- Measuring cup
- Measuring teaspoon
- Spoon for Mixing
- Digital Thermometer

* If working alone cut the recipe in half or plan to share!

Step 3: Specifications and Constraints

To design the ice cream, we must first identify the specifications and constraints.

Specifications are what your solution must do or possess. They are the requirements.

Constraints are things that limit your solution.

What are the specifications and constraints for this challenge? Check off the correct answers below.

	SPECIFICATION	CONSTRAINT
Limited time	<input type="checkbox"/>	<input type="checkbox"/>
Limited materials	<input type="checkbox"/>	<input type="checkbox"/>
Ice cream has no crystal formations	<input type="checkbox"/>	<input type="checkbox"/>
Ice cream has solid consistency	<input type="checkbox"/>	<input type="checkbox"/>
No salt contaminates mixture	<input type="checkbox"/>	<input type="checkbox"/>

Step 4: Design Criteria

Below is the rubric you will use to rate your design.

Criteria	One	Two	Three
Temperature	The ice cream is still liquid	The ice cream is like soft serve	The ice cream is solid
Consistency	Has crystal formation	Has little crystal formation	Creamy texture, without crystals
Taste (after removing ice cream from shaker)	Could be better	Not bad	Delicious
Temperature of the salt/ice/water mixture	Temperature is 32F	Temperature is between 32 F and 15 F	Temperature is 15 F or lower.

Knowledge and Skill Builder—Freezing Point Depression

Water freezes at 32 F to become ice. Because you need to chill the ice cream mixture far below 32 F to make solid ice cream, you will need more than ice to get the job done.

Salt lowers the freezing point of water. A 10% salt solution freezes at 20 F, a 20% solution freezes at 2 F. This drop in temperature is called freezing point depression- the freezing point of water is lowered so it freezes at a much lower temperature than it would originally.

Chilling your ice cream mixture in a salt/ice solution is what you need to do. As the ice cream mixture chills, it is important to keep it moving to prevent ice crystals from forming. Fewer and smaller crystals equals creamier ice cream. The trick is to keep it moving!



Step 6: Self-Quiz!

Based on what you read on the previous page, answer the following questions:

1. Why is it important to lower the temperature below 32 F?

- The lower the temperature of the ice/salt/water mixture, the faster the ice cream will freeze.
- The lower the temperature of the ice/salt/water mixture, the slower the ice cream will freeze.
- The higher the temperature of the ice/salt/water mixture, the faster the ice cream will freeze

2. What happens when the mixture is not kept in motion?

- Melts and separates into its original condition
- Stays the same temperature and consistency
- lumps and crystals form

Step 7: Understanding Freezing Point Depression

To make ice cream you will need an effective ice bath. Set up your ice bath but first, test freezing point depression in the ice bath. For the testing phase you will need 1/2 cup of salt, 4 cups of ice and a thermometer. Start testing the variables below and keep track of your results.

1. Add Four cups of ice cubes to the 3 quart container. Measure the temperature of the ice. What is it?

2. Then add 1/4 (quarter) cup of salt to the container. Stir the mixture thoroughly. What is the temperature of the mixture?

3. Add another 1/4 (quarter) cup of salt to the container. Stir the mixture thoroughly. Now what is the temperature of the mixture?

Step 8: Making Your Ice Cream

Gather the materials and make ice cream:

1. Place $\frac{1}{2}$ cup of sugar, 2 teaspoons Vanilla Extract, and 2 cups (one pint) half & half into a medium sized mixing bowl.
2. Stir until the sugar dissolves.
3. Carefully pour the ice cream mixture into two or three zip lock bags depending on the number of people participating. There will be plenty of ice cream for each of you!
4. Gently squeeze the bag and make sure it is sealed tight. Place the sealed zip lock bag into a second zip lock bag for extra protection. You don't want salty ice cream!
5. Place the bags into the salt/ice/water mixture that you made and tightly seal the lid.
6. With the lid closed, take turns shaking the container for 5 minutes.
7. Carefully open the container, measure the temperature of the salt/ice/water solution and feel the consistency of the ice cream through the bags. Is it liquid or is it starting to freeze?
8. Shake for another 5 minutes and remove the ice cream for testing. Is it ready or does it need 5 minutes more of shaking?

Step 9: Test and Evaluate

Criteria	One	Two	Three
Temperature	The ice cream is still liquid	The ice cream is like soft serve	The ice cream is solid
Consistency	Has crystal formation	Has little crystal formation	Creamy texture, without crystals
Taste (after removing ice cream from shaker)	Could be better	Not bad	Delicious!
Temperature of the ice/salt/water mixture	Temperature is 32 F	Temperature is 25 F	Temperature is 20 F or lower

Use the Design Evaluation Criteria to rate your final ice cream.

Total Score:

Step 10: Reflection

Reflection: Describe what you learned about how ice cream is made:



Step 11: Design Solution

Congratulations! You have successfully used food chemistry and engineering design to make your own ice cream. With this recipe and using freezing point depression you can delight your family and friends with Ice cream all year long!

