

# Can you make ice cream in two minutes?

A laboratory experiment from the  
Little Shop of Physics at  
Colorado State University



## Theory

Freezing cream, milk, and sugar with liquid nitrogen is a nice demonstration, and a great excuse to eat ice cream. Most of the air we breathe is nitrogen (about 78%), and about 20% is oxygen. Liquid nitrogen is very cold:  $-320^{\circ}\text{F}$  or  $-196^{\circ}\text{C}$ . While liquid nitrogen is used for many temperature-related applications, it's particularly useful for freezing foods because nitrogen is odorless, colorless and tasteless.

The very cool thing about this demonstration is this: When you add the liquid nitrogen, it boils. This takes heat energy from the ingredients. The ingredients then freeze. So you have two different phase transitions happening in one bowl: boiling and freezing. It's a great way to show the energy exchanges in phase transitions.

The secret to the creamy ice cream is all in the rapid freezing of the mixture. The liquid nitrogen causes the fat and the water particles to stay very small, giving the ice cream its creamy consistency. The goal is to avoid ice crystals - similar to what you get when you make ice milk.

## Necessary materials:

- liquid nitrogen
- gloves and goggles
- large stainless steel punch bowl or salad bowl
- 1 quart of heavy cream
- 1 quart of whole milk
- 1 pound of sugar
- flavoring
- wooden spoon

## Doing the Experiment

1. Pour the cream, milk, and sugar in the bowl. You can simply pour the ingredients in; it uses full quantities of all of them, so it's quick to get started! A bit of mixing wouldn't hurt, but isn't crucial.
2. If you are making vanilla or chocolate ice cream, whisk in vanilla or chocolate syrup now. Add any other liquid flavorings you might want.
3. Put on your gloves and goggles. Pour a small amount of liquid nitrogen directly into the bowl with the ice cream ingredients. Continue to stir the ice cream, while slowly adding more liquid nitrogen. This is best done by two people. You need to stir, not whip! You want to have pockets of liquid nitrogen mixed with the ingredients so that the necessary heat exchange can take place. But don't whip it up; if you get bubbles, you'll make a frothy mess.
4. Continue to stir the liquid nitrogen and the liquid ingredients. As it hardens more, remove the spoon and just pour the remaining liquid nitrogen onto the ice cream to fully harden it.
5. Allow the excess liquid nitrogen to boil off before serving the ice cream.

## SAFETY NOTES:

**If you are using a metal container for the liquid nitrogen, be sure to wear gloves. Don't touch liquid nitrogen or store it in a closed container!**