Teacher's Guide for:

Liquid Nitrogen

Note: All activities in this document should be performed with adult supervision. Likewise, common sense and care are essential to the conduct of any and all activities, whether described in this document or otherwise. Parents or guardians should supervise children. Rock-it Science assumes no responsibility for any injuries or damages arising from any activities.

NOTE: *This is the transcript of a lesson that was videotaped during an actual Rock-it Science class with real students, not actors.*

Contents:

Title Page of Video:

Liquid Nitrogen
A Rock-it Science Lesson
Filmed March 2011

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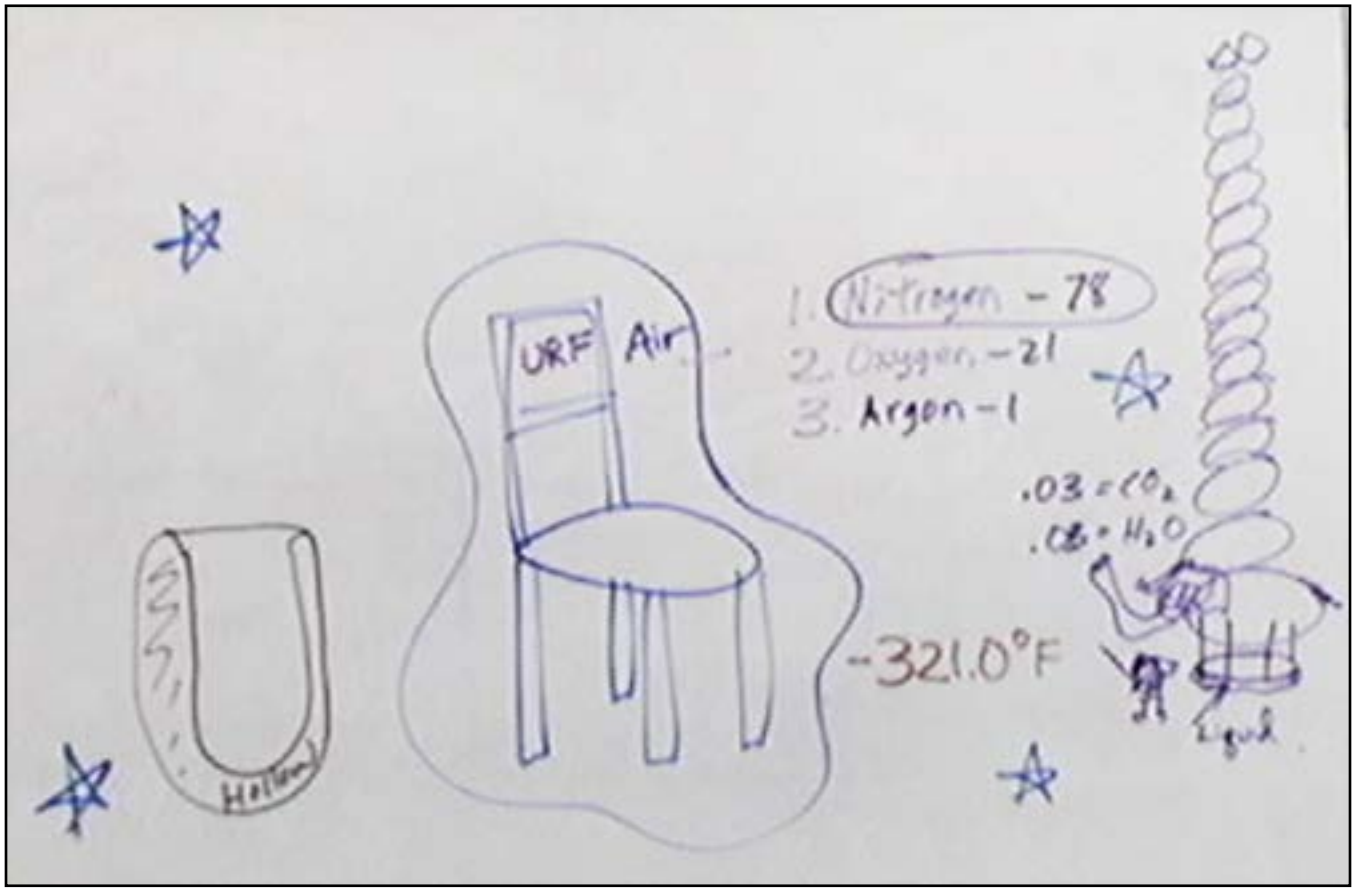
Intro Quick Recap:



- There's a chair called URF floating in space, surrounded by atmosphere.
- Its atmosphere is the same as Earth's. It's composed mainly of three things. What are they? (Students answer.)
- 1. Oxygen. 2. Nitrogen. 3. Argon
- If there were one hundred pieces of air around URF, 78 of them would be Nitrogen, 21 of them would be Oxygen, and 1 would be Argon. Argon just sits there and does nothing.
- What about the stuff that the trees and plants breathe? There's only .03 pieces of that.
- The clouds (water vapor) are also only .03 pieces.
- A guy wanted to do something with Nitrogen. He filled a tin can with it and then put a hundred elephants on top of it.
- The can got squished, and the nitrogen turned into a liquid and got smaller.
- Then the elephants jumped off, and some of the nitrogen turned into a gas, but most of it stayed liquid.
- Then the little guy came along who had put his finger in the dike to stop the flood. But this time he had a hammer and nail, and he poked a hole in the can. And out came liquid nitrogen.

Intro Quick Recap (cont.):

- Show students the tank of liquid nitrogen, and make some of it come out through the hose.
- Put the hose in the thermos bottle and let it fill up while the intro continues.
- The thermos has a hollow shell where the air has been sucked out. This empty space keeps the heat or cold inside.
- Liquid nitrogen is 321.0 degrees below zero F. Dry ice is only -109 degrees F. So you can remember that dry ice is about 100 degrees below zero and liquid nitrogen is about 300 degrees below zero.
- When the thermos is full, pour some liquid nitrogen into a clear cup so students can see it bubble. Then pour it onto the table and let students slap the little balls of liquid.
- Liquid nitrogen is cold enough to freeze your finger and make the skin peel off. But if you have rough adult skin (not smooth child's skin), you can stick your finger in and then take it out immediately, and you won't get hurt.
- On the internet, they showed a slow-motion video of a finger going into a glass of liquid nitrogen. The nitrogen formed bubbles around the skin, and this protected the skin from the coldness.
- You don't want to scoop up a puddle in your hand, because your hand will freeze where the puddle sits.

Experiment Quick Recap: *"Liquid Nitrogen"*

Part One: Make Leafy Greens "Soup"


Stirring the fog.

- Students work in teams of two. They stand up and push chairs back to avoid spilling liquid nitrogen into their laps. Clothes would absorb the liquid nitrogen and cause their skin to freeze.
- Students have to wear goggles to prevent getting splashed in their eyes, which would cause a spot on the cornea that takes a long time to go away. All students wear goggles, even if they wear glasses.
- Each team gets a clear plastic cup. Instructor pours a small amount of liquid nitrogen in each cup. Students watch it boil and see how long it lasts.
- They can put their finger in the cold fog above the liquid nitrogen and swish it around to see if they can make it spin.
- Give each team a small styrofoam cup and have them pour whatever is left of their liquid into the cup. They can pour it back and forth.
- Collect the clear cups and pass out fat craft sticks for stirring. Let students stir it and see if it does anything.
- Pass out leafy greens. Students put them in their cup and stir and poke it to break it up.
- Add a piece of celery, and a piece of paper towel.
- If celery doesn't break up, students can put it on the floor and jump on it.
- Add a little more liquid nitrogen if needed.
- Students sometimes poke holes through the cup, so they may need to put it inside a second cup.
- Add a bouncy ball to each cup and let it freeze for at least 60 seconds. Then take it out and bounce it on the floor. It should sound hard like a marble at first.
- Collect bouncy balls, then have students dump their cups and sticks into the trash can.


Leafy greens "soup."

Part Two: Freeze Ice Cream and Marshmallows


Stirring ice cream.

- Give each student a small Styrofoam cup with two spoonsful of ice cream in it. Have them stir it with a plastic spoon to make it as soft as possible.
- Add liquid nitrogen to each cup. Students should start stirring right away so it doesn't freeze the spoon in place.
- Students stir and stab and try to mix the liquid nitrogen with the ice cream.

Experiment Quick Recap (cont.): *"Liquid Nitrogen"*

- When it stops sizzling, they can eat the ice cream.
- Teacher puts a bunch of mini marshmallows into a Styrofoam cup and adds liquid nitrogen.
- Show students how to chew a frozen marshmallow with their mouth open to make "smoke."
- Teacher passes out a marshmallow to each student. If there's time, they can have a second one.
- Throw away cups and sticks.

Demo: Freeze Balloons (In the video, this was presented during the end of the Story, but it's usually done immediately after the experiment.)

- Put a bunch of inflated balloons into a Styrofoam cooler and add liquid nitrogen. After the balloons flatten out, use tongs to put them on the table. Students can touch them if they want while the balloons re-inflate.

Shrinking balloons in cooler.

Equipment List: "Liquid Nitrogen"

Items needed for Instructor:

- Dewer of liquid nitrogen
- Transfer hose
- Small dewer or Thermos
- Leather glove
- Styrofoam cooler
- Tongs
- Cup, clear plastic, 16-oz.
- Balloons, 12-in., about 20
- Wastebasket

Prep Work:

- Fill liquid nitrogen tank
- Transfer liquid nitrogen to small dewer before class
- Buy leafy greens, celery, ice cream, and marshmallows.
- Allow ice cream to soften before class.
- Inflate 20 balloons

Items needed for Students:

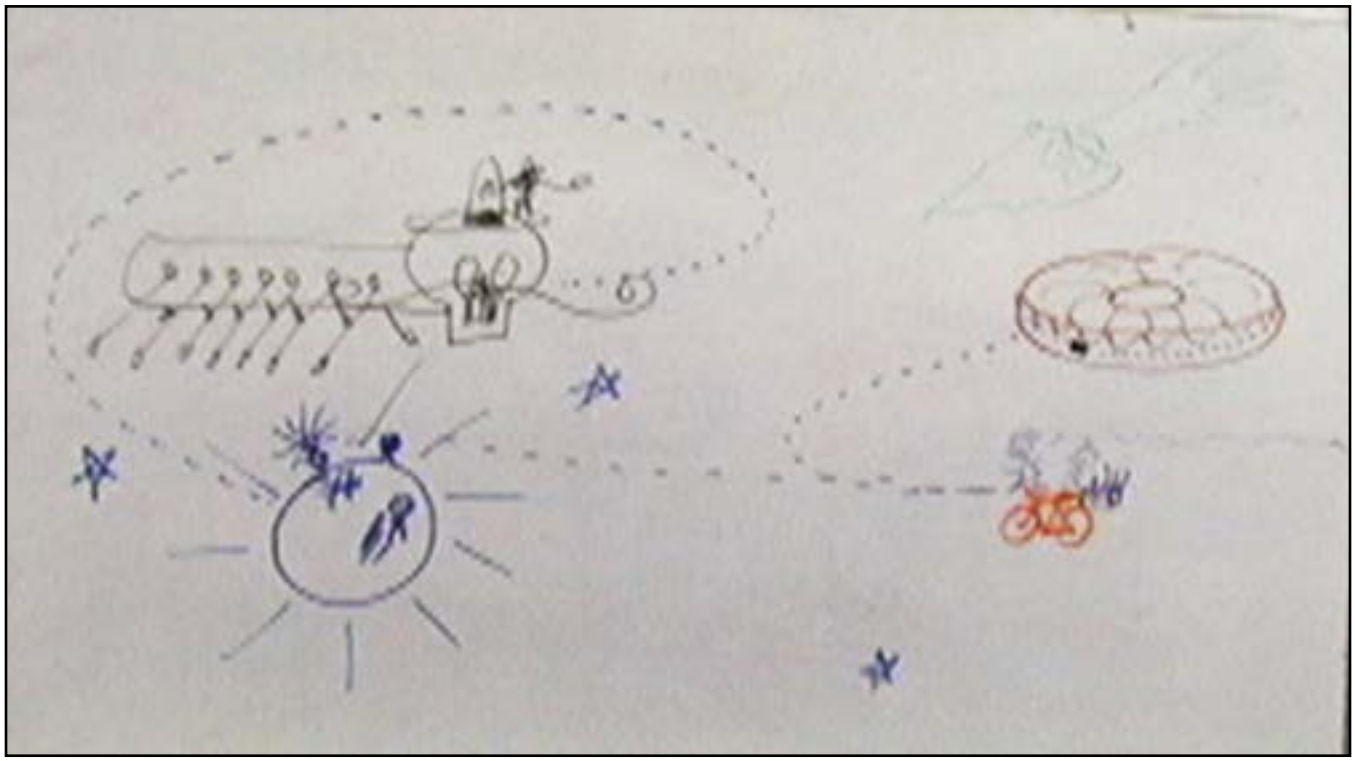
Consumables:

- Cup, clear plastic, 16-oz (one per team)
- Leafy greens (one leaf per team)
- Celery (1-in. piece per team)
- Paper towel (approx. 2 sq inches per team)
- Cup, styrofoam, 4-oz (one per team)
- Cup, styrofoam, 4-oz (one per student, for ice cream)
- Ice cream, softened (approx. 1/2 oz. per student)
- Plastic Spoon (1 per atudent)
- Craft stick, large (one per student)
- Mini-marshmallows (two per student)

Other (per student):

- Bouncy balls (one per team)
- Goggles

Story Recap: *"Evil Mister Fred's Death Star"*



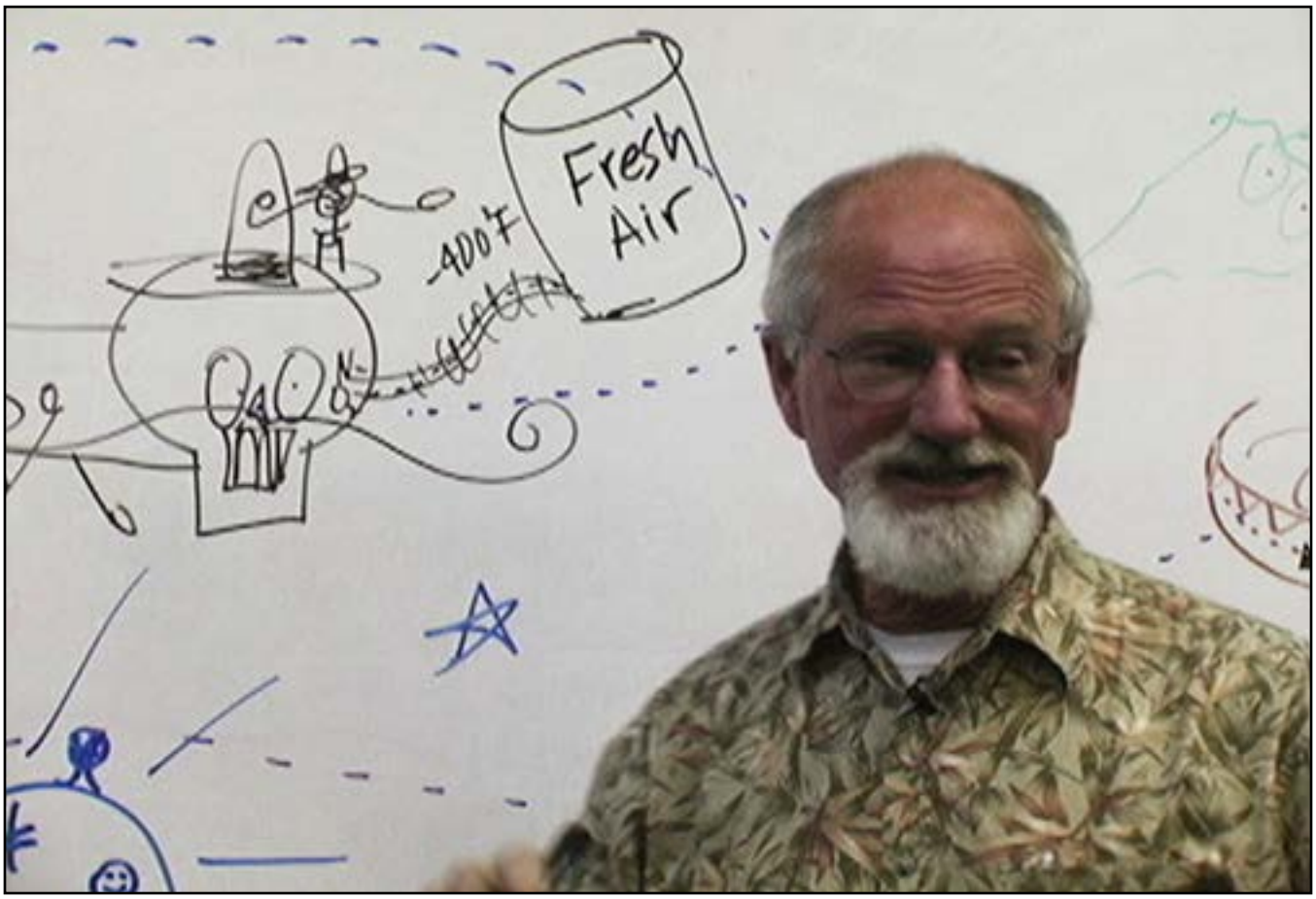
Part 1:

- Evil Mister Fred wants to rule the universe, so he orders a death star.
- The propulsion unit is at the back, with oars sticking out for the minions to row.
- The death star is a battering ram that can ram any planet and smash it to bits.
- Since Evil Mister Fred is cheap, he bought a really cheap death star. It's a balloon that's been inflated, and all the minions are inside.
- He decides to test it on a planet that is also a balloon. The people who live there really like it because it's a giant trampoline. Anywhere you go, you can bounce.
- Evil Mister Fred called for ramming speed, but the minions turned the wrong way, so they had to come around again and ram the planet.
- The death star has a pin sticking out of its nose. When it hit the planet, the planet exploded and the people went flying into space screaming
- You can only survive for 29 seconds in space.
- Jack and Jill came by on their tandem bicycle with a little box.
- The saw the planet explode, so they rescued the people by stuffing them into the box.
- Evil Mister Fred said that wasn't fair, but Jack and Jill just took their box and headed away from Evil Mister Fred.
- Evil Mister Fred told the minions to follow them.

Story Recap (cont.): *"Evil Mister Fred's Death Star"*

- Jack and Jill headed for a chocolate doughnut planet. They entered through one of the transport openings and delivered all the people who were in their box.
- Evil Mister Fred decided to attack the chocolate doughnut planet.
- Jill called out and summoned a giant green squid.
- How can you protect the planet and make sure the squid doesn't die?

Story Recap (cont.): *"Evil Mister Fred's Death Star"*



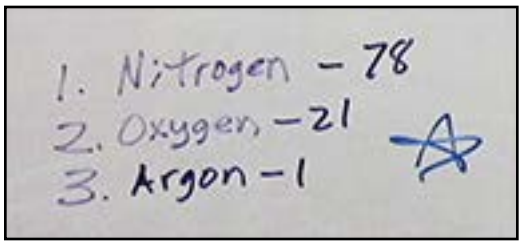
Ending:

- Evil Mister Fred wants to attack the doughnut planet.
- Jill wants to do something nice for him so maybe he'll stop being evil.
- They ordered a big canister of fresh air and had it delivered to the death star.
- There was a tube that came with it, and Evil Mister Fred was using it to pump the fresh air into the death star.
- But Evil Mister Fred didn't like the rubber covering on the tube, so he tore it off.
- The temperature of space is -400 degrees.
- As the air came through the tube, it turned into liquid. First came liquid oxygen, then liquid nitrogen.
- The death star, which is a balloon, shrunk down to almost nothing. The giant squid ate it, along with Evil Mister Fred.

Transcript: Intro

Let's see, you guys live on a planet, right? *[Student: We live on chairs.]* Okay, let's suppose there's a chair floating in space. And chairs have legs, right? And they have a back. There -- there's a chair floating in space. And the chair is surrounded by atmosphere. It's like sky, air, and stuff like that.

And this chair happens to be a lot like URF -- it's called an URF Chair. And it has the same kind of air as URF does. And the air around URF is made of three things mostly. Thing number one, thing number two, and thing number three. Does anyone know what thing number one or two or three is?



[Student: Oxygen.] Okay, oxygen. That's thing number two. *[Student: Nitrogen.]* Nitrogen, that happens to be thing number one.

Well, nobody knows about thing number three because it's always hiding. It's always gone, so they call it Argon. That's thing number three.

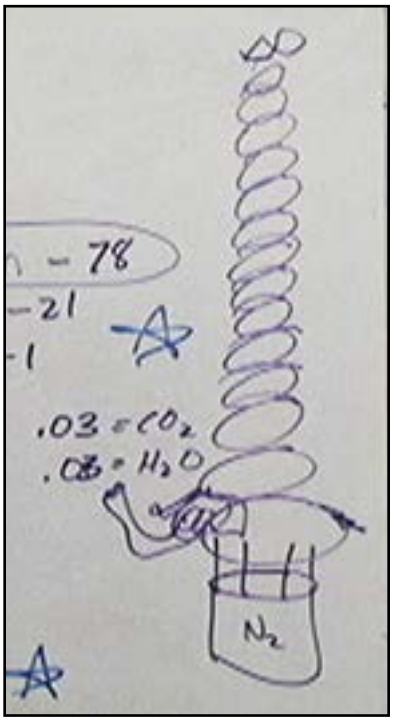
If there were a hundred pieces of air around URF, seventy-eight of them would be the nitrogen. About twenty-one of them would be the oxygen. And about one of them would be the argon. Argon is an inert gas that just sits there and does nothing. It twiddles its thumbs a lot.

Now, you might say to yourself, "Wait a minute. You forgot something. What do the trees breathe? And the grass? And the plants? What is that stuff?" *[Student: It comes from us.]* It comes from us, but it's got to be in the air, right? Otherwise the plants would die. You know how much there is of that? .03 *[writes .03=CO_2]*.

And then there's something else that you should say: "What about the clouds?" .03 is the H_2O.

Well, people figured this out, and somebody said, "I want to do something wtih the nitrogen." So he went and got himself a hundred elephants. And a tin can. And he put nitrogen in the tin can -- it wasn't a very big tin can. *[Writes "N_2" on can.]* They write it that way for chemists. And then he put a hundred elephants on top of it. There. What happens when you put a hundred elephants on top of a tin can? *[Student: It collapses.]* It collapses, yeah.

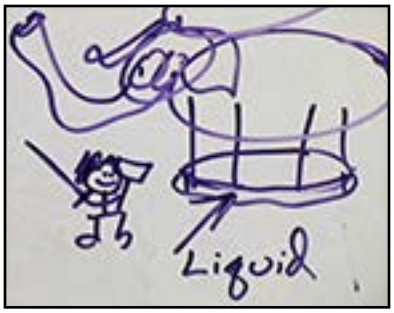
So imagine a hundred elephants, or two hundred elephants -- there, an infinite number of elephants. And the tin can squished -- squash! And all the elephants went down. There it is, squished.



Elephants on a tin can.

Squished can.

Well, something weird happened to the nitrogen. If you get enough elephants on there and you squish it hard enough, the nitrogen turns into a liquid. And as a liquid, it gets a lot smaller. And then all the elephants jumped off. And the nitrogen expanded, and some of it turned into a gas, but the rest stayed as a liquid.



And then along came the little guy who stuck his finger in the hole in the dike to prevent the great flood. But this time he had a hammer and a nail. And he poked a hole in the can, and out came liquid nitrogen!


Liquid nitrogen dripping out of the hose.

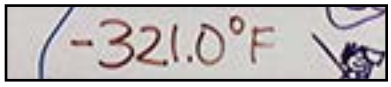
This tank has liquid nitrogen in it. Here's an elephant trunk. It sounds like an elephant when I turn it on. And that stuff dripping out is liquid nitrogen. Well, we're going to put some in a thermos bottle over here. There, you hear it? It's gurgling and steaming and doing liquid nitrogen kind of stuff.

[Student: What is the thermos like?] What is the thermos like? The thermos is a glass bottle. Imagine a glass bottle that's been made with a hollow inside. It's hollow here. And the hollow part, they sucked all the air out. Makes for a nice place to store liquid nitrogen. So when you suck the air out, the heat stays in. Or the cold stays in, too. You can see how it comes out, it just barely drools out.


Filling thermos.

Thermos.

Liquid nitrogen is cold. It's 321.0 degrees Fahrenreit below zero. If you remember three-two-one-zero, that's how cold it is. Don't forget the point, though. That's how cold it is.

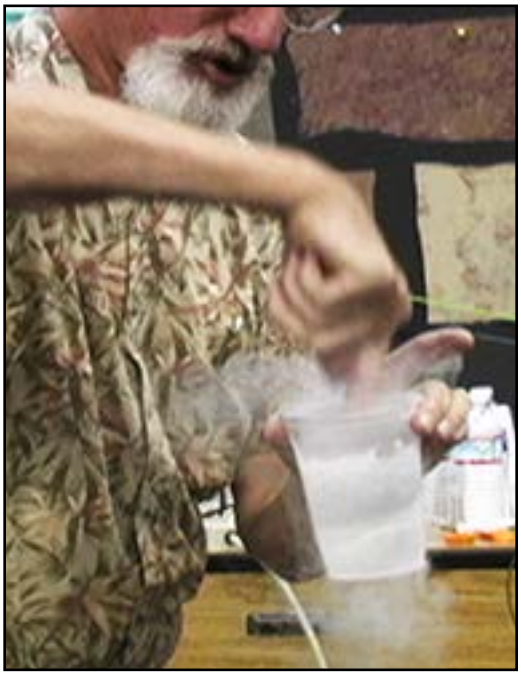


Do you remember how cold dry ice is? Was dry ice as cold as that, or not as cold as that? Dry ice is 109 below zero. So if you want to remember an approximate number, dry ice is a hundred below zero, and liquid nitrogen is three hundred below zero.

That should be enough. I'll turn it off, and we'll let this drain out. There. Now we have some liquid nitrogen in a flask. We can put a little bit in a cup. There's some liquid nitrogen in a cup. And you can see that it looks like water. And if you pour it on a table, it makes little balls. See the little balls? When a little ball comes by, smack it. There they go! Hit the little balls.


Pouring liquid nitrogen onto the table.

The liquid nitrogen forms little balls.



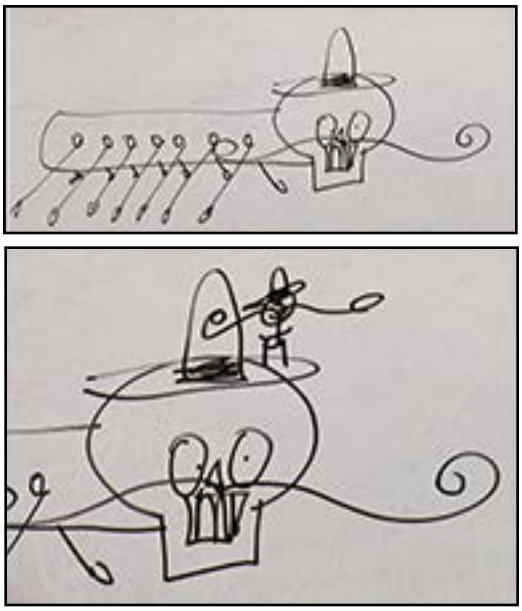
If you put your finger in,
take it out *immediately!*

Now, if liquid nitrogen didn't do something that it does do, and you stuck your finger in there, your finger would freeze instantly. And the skin on the outside of your finger would die and then peel off, and you'd do the ooh-ah-ooh-ah dance. However, it does do something weird so that your skin doesn't peel off and you don't do the ooh-ah-ooh-ah dance.

There's liquid nitrogen in the cup. You're not supposed to do this if you have tender skin, but if you've got old beat-up man skin you can do it. You put your finger in there and go whoosh *[puts finger in liquid nitrogen and immediately takes it out]*. And it doesn't make make my finger crack and fall off.

Now, on the internet they had a nice clear glass, and they took a high-speed picture of the finger as it went in. So it looks like slow motion. It went in there, and bubbles formed all around the finger, and the bubbles of nitrogen protected the skin from the coldness. And you can do it fast like that. However, you don't want to accidentally scoop any of it up and have a little puddle in your hand, because the little puddle will freeze the skin where it sits. So you want to just do a quick one, if you ever have to do it.

Story: *"Evil Mister Fred's Death Star"*

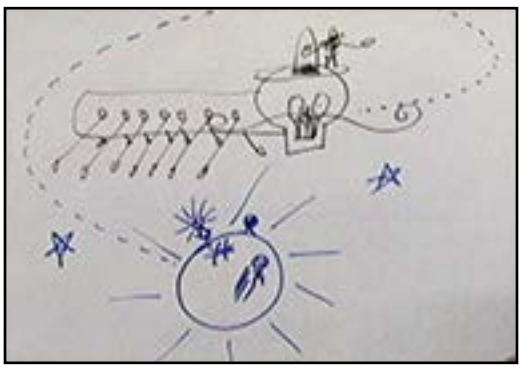


Evil Mister Fred and his Death Star.

Let's suppose that Evil Mister Fred has decided to change his priorities, his goals, his meaning for what he should do in life. So instead of just trying to take over the world, he decides he wants to take over the universe. Gotta aim high! So he called the Acme Store of Everything and ordered a Death Star. There's Evil Mister Fred's Death Star, and this is a propulsion unit in the back. It's got windows there with oars sticking out, and the minions have to row his Death Star through space.

And his Death Star is made to be a battering ram, to ram any planet and blow it to bits. And Evil Mister Fred made this thing, and he was kind of cheap. He didn't want to buy the first-class model, and he didn't want to buy the second-class model, and he didn't want to buy the third-class model. What he got was about the hundredth-class model. It's a balloon and floating in space. It's been inflated, and all the minions are inside. And he decides to test it out on one of the local planets.

And there's a planet down there, and it was made also out of a balloon, floating in space. And there's a bunch of people down there who like this planet because it's a giant trampoline. You go boing, boing, boing -- anywhere you go, it's a trampoline. You just have to wear sock feet because it's a balloon. You don't want to pop it. So there's all these people down there bouncing around, having a great time.



The Death Star popped the Balloon Planet.

And Evil Mister Fred said, "All right, ramming speed!" And the minions said, "Okay, boss!" And they started to row as fast as they could go. But they were going the wrong way. He says, "Turn to the right!" And the minions turned to the left. And he says, "All right, circle around to the left!" So they circled around to the left, and they rammed the big balloon. And they hit the balloon, and Evil Mister Fred's death star happened to have a pin sticking out of its nose, and they popped the balloon. And now all these people are flying through space. You can only survive for twenty-nine seconds while flying through space.

And they were going, "Aaaaaahhhhhh!" -- like that, because all the air was coming out of their lungs.

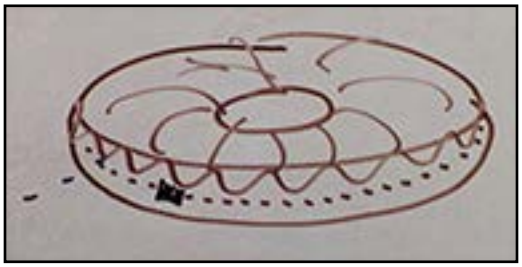
Jack and Jill on their bicycle.

Well, it just so happened that Jack and JIll were riding by on their bicycle. Jack and Jill had a nice bicycle, and they were out for a ride in space on a tandem bike. Jill was on the front and Jack was on the back,

like that, flying through space. And they had with them a tiny little box -- there. And they saw the planet implode. And they saw the people all screaming, "Aaaaaahhhhh!" for twenty seconds. Jack and Jill said, "Never fear! We will rescue you!"

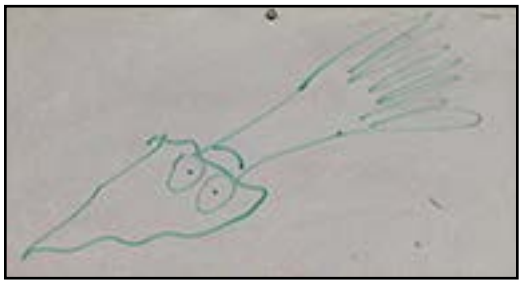
And they zoomed by on their bicycle and started stuffing peole into their box. Every person they came to, they stuffed them all into the box. They stuffed three billion people into their box. And Evil Mister Fred said, "No! You can't do that! That's not fair!" And Jack and Jill said, "Nyah, nyah, we can do what we want." And Jack and Jill headed off away from Evil Mister Fred. And Evil Mister Fred said, "Catch them, minions!"

And Jack and Jill headed for the chocolate doughnut planet. A chocolate doughnut has to have a hole in it and be covered with chocolate frosting, like that. And Jack and Jill quickly rode in, went through one of the transport openings here, and rescued all those people from The Evil Mister Fred. And Evil Mister Fred said, "Now I know who my next victim is! I'm going to destroy the chocolate doughnut planet."



Chocolate Doughnut planet.

And Jack and Jill said, "We're going to need some help." So Jill yelled out the windows and called for help. And along came a giant green squid-looking thing who likes coconuts. So the squid was coming from one way, Evil Mister Fred was coming from the other way, and Jack and Jill said, "Whoa, this is going to be good."



Giant Squid.

Now if you were Jack and Jill and you wanted to protect the planet and make sure the squid doesn't die, what would you do?

Imagination Time

[Students make suggestions] (THERE ARE NO WRONG ANSWERS! Whatever they say, you should reply: "That's a good idea," "They might do that," etc. After brainstorming, proceed with the experiments, then finish the story.)

We'll leave this "To be Continued . . ."

Experiment: *"Liquid Nitrogen"*

Part One: Make Leafy Greens "Soup"

For our first experiment, we want to see how quickly liquid nitrogen evaporates into the air. You're goinig to need a partner, so pick a victim to work with. Go sit next to your victim. *[Passes out a plastic cup to each team.]* Since you guys are wearing clothes, and clothes absorb liquid nitrogen, you don't want it to spill in your lap. So let's move the chairs way far away from the table and stand up. And since you guys are using eyes, we need to protect your eyes. You have to use goggles over your eyes. If you get liquid nitrogen on your eyes, it leaves little spots on your cornea, and it takes awhile for them to go away. So everyone needs to wear the goggles. Glasses aren't good enough for this. These have to be spill-resistant.

[Instructor pours a small amount of liquid nitrogen in each team's cup.] There, you can just watch it boil. We'll just see how long it lasts. You can put your finger in the cold air above the liquid and just stir a little bit. See if you can make it spin.


Stirring the fog.

Now we're going to give you a white foam cup. Whatever is left in your clear cup, pour it into your white cup. If you want to, you can pour them back and forth, if there's anything left. Now I'm going to collect the clear cups. The white cups are going to work better for what we're doing today.

Now let's give you some fat sticks *[passes out large craft sticks, then pours some more liquid nitrogen into each cup].* And stick the stick in the liquid nitrogen and see if it does anything.

Now we'll give you some leafy greens. And put the leafy greens in the liquid nitrogen. Put them in and stir them up. You're making leafy green soup. Stick them in there, stir them all up good. Smash it all up and see how small you can make it. You can hold the cup if you want -- the cup is insulated. Okay, that looks like it's pretty good leafy green soup.


Leafy greens "soup."

Soup is never complete until you put celery in it, right? So put some celery in your soup *[passes out small chunks of celery].* And for special seasoning, put some paper towel in your soup *[passes out pieces of paper towel].* If you want to, you can take the celery out, throw it on the floor, and jump up and down on it.


Bouncy ball.

Okay, next we're going to freeze a bouncy ball. And a bouncy ball has to freeze for at least sixty seconds. So we're going to look at the clock. *[Passes out a ball to each team.]* You can put it in the soup. The liquid level needs to be above the bouncy ball *[adds liquid nitrogen to each cup].* After your bouncy ball is completely frozen, then take it out and bounce

it on the floor. It should sound like a marble when you first start. Just keep bouncing it gently. *[Student: Can we hold the bouncy ball?]* Yes, you can hold it.

Okay, next we're going to be freezing some ice cream. Bouncy balls go in here *[brings out a storage container for the balls]*. Take your white cup and your stick and drop it in here, steaming garbage can *[wastebasket]*.

Part Two: Freeze Ice Cream and Marshmallows

We're going to be freezing ice cream and marshmallows. If you don't eat ice cream usually, don't eat it. But you can certainly play with it as long as you want. You can eat it afterwards if you feel like it.

Stirring melted ice cream.

The way to work it is, I put some amount of ice cream in the cup -- maybe two scoops is good. And then when you get it, I'll hand you the spoon and the cup, and you stir and stir and stir and try to melt it as much as you can. Then we're going to pour in liquid nitrogen. Then you're going to keep stirring with liquid nitrogen in it until you can't stir any more. And then you're going to stir it and say, "I can't stir it anymore." Then while we're waiting for it to become thawed enough to stir again, we'll do the marshmallows. *[Passes out a small cup of ice cream and a plastic spoon to each student, and they stir it.]*

Your goggles need to be on for this. I'll pour in some liquid nitrogen, and then you stir and stab and squish and push and try to mix the liquid nitrogen into the ice cream. While you're doing it, it'll sizzle in the cup. After it stops sizzling, then you can eat it. This is how the make the expensive ice cream. *[Adds liquid nitrogen to each cup.]* As soon as you get it, start stirring and stabbing at it. Don't just stand there. Listen to it. When it stops sizzling, then you can eat it. If yours is hard as a rock, you're going to have to wait until we do the marshmallows.

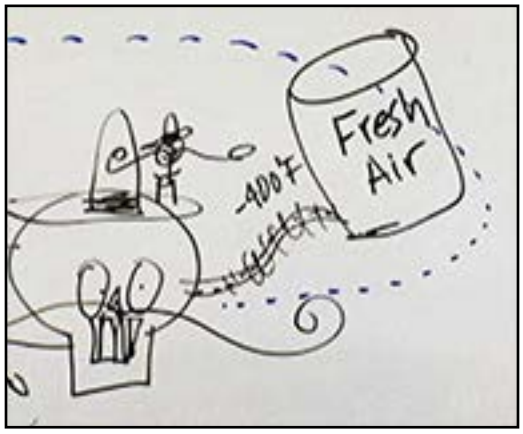
Marshmallow fog.

When you eat a marshmallow that's been frozen with liquid nitrogen, there's a certain technique. In order to make it look good for your neighbors, you want to put it between your teeth and kind of go *[pantomimes chewing with his lips open],* showing your teeth while you're scrunching. So if you want to do a marshmallow, when I come by put your hand up and I'll drop one in your hand. *[Instructor puts a bunch of marshmallows in a cup of liquid nitrogen and uses a plastic spoon to lift them out one at a time and place them in the students' hands. Students pop the marshmallow in their mouth and chew it, which causes fog to come from their mouth.]*

[Student: Is this how they make freeze-dried food?] Yes it is. After they freeze it like this, then they put it in a vacuum chamber and suck all the moisture out. That's freeze-dried food. *[Instructor passes out another marshmallow.]* Now, when you're done with your cups, just chuck them in the trash can.

Story End

Evil Mister Fred's out there in space with his Death Star, and he's going to attack the doughnut planet. And Jack and Jill said, "We've got to do something about that guy. He's causing all sorts of trouble." And Jill said, "Yeah, I guess he is, isn't he? Hmm, I wonder what we could do for him." And Jack said, "You don't want to do anything FOR him; we want to do something AGAINST him." And Jill said, "Yeah, but maybe if we did something for him, he would stop being evil." And Jack said, "Okay, fine. What do you want to do?"



Fresh Air delivered to the Death Star.

And Jill said, "Let's ship him a nice big canister of fresh air." And Jack said, "Fine. Give him some fresh air. Maybe he'll breathe it and become a new person." And Jill said, "Yeah, that's it!"

So they called the Acme Store of Everything and they ordered a great big tank of fresh air. And the Acme Store of Everything said, "Well, where do you want it delivered?" And Jack and Jill, of course, said, "To the Death Star." So they delivered a big old can of fresh air. And there was a tube, and Evil Mister Fred was pumping the fresh air into his Death Star. Well, he didn't like the tube. There were all kinds of rubber coverings around the tube. And Evil Mister Fred said, "Huh! Rubber coverings -- don't need that! We're tough around here!" So he threw the rubber coverings off. Well, the temperature of the air in space is minus 400 degrees. And as the fresh air was going through the tube, it started turning into liquid. The first thing that came through it was pure oxygen. And then the liquid nitrogen came through, and it started going into Evil Mister Fred's balloon. And as it did, something weird happened. Here's what happend to Evil Mister Fred's balloon.


Balloon in cooler.

[Instructor pours liquid nitrogen into a large styrofoam cooler.] Here comes the liquid nitrogen from the Acme Store of Everything. *[Puts inflated balloons into the cooler and uses a styrofoam cup to push them down into the liquid nitrogen as they shrink.]*


Deflated balloon.

Now Evil Mister Fred's Death Star is just like this balloon *[uses tongs to pull out the deflated balloons and toss them onto the table, where they gradually re-inflate].* And Evil Mister Fred's spaceship shrunk down to nothing. He said, "Aaaaaahhhhhh!" just before he froze to death. And the giant squid came over and ate the balloon and Evil Mister Fred. And they all lived happily ever after, except Evil Mister Fred.

End of Lesson