



Teacher's Guide for:

Dry Ice

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. The students' brainstorming comments are included on the video but are not transcribed here because they're not part of the lesson presentation.

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Dry Ice
A Rock-it Science Lesson
Filmed October, 2009

Rock-it Science

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Intro & Demos Quick Recap:

Lesson Intro: How to Handle Dry Ice



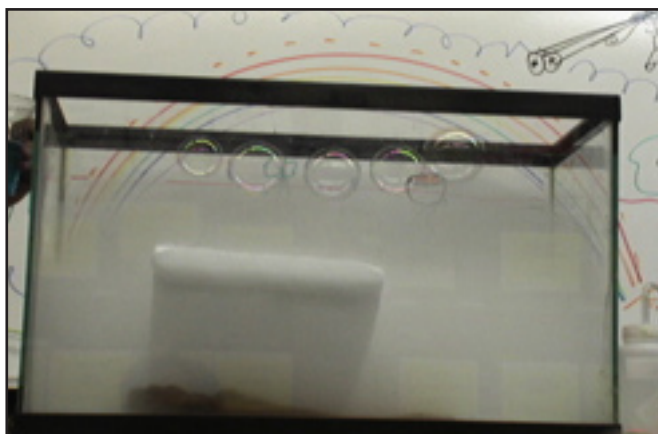
Instructor explains what dry ice is (carbon dioxide at 109 degrees below zero). Instead of melting, it goes directly from a solid to a gas (sublimation). If you leave your hand on it for 12 seconds, you'll get frostbite. But you can safely handle it if you just stroke it for a second or two. Bring the dry ice around and let students stroke the edge of the slab.

Demo #1: Candle Flame



A slab of dry ice is placed into the aquarium. A candle goes out when lowered into the invisible cloud of carbon dioxide. The same demonstration is also done with a cigarette lighter, and the flame gets smaller or larger as the lighter is raised and lowered.

Demo #2: Sloshing Fog & Bubbles



A cup containing dry ice and hot water is placed into the aquarium to create fog at the top, then ground fog. Carbon dioxide fog sloshes like water, and soap bubbles float on top of it.

Demo #3: Exploding Balloon



Dry ice and hot water in a plastic bottle make the balloon expand, like the science teacher's freezer that exploded.

Experiment Quick Recap: "Dry Ice"



Each student gets a cup with dry ice and an aluminum bar that screeches on contact.



When hot water is added, fog pours out of the cup and spreads over the table.



A few drops of dish soap are added, causing bubbles to pour out.



Instructor breaks each student's ice egg, exposing the dry ice inside the water ice shell.



Some plastic film cans with dry ice inside are set on the table to spontaneously explode.

Equipment List: "Dry Ice"

Items needed for Instructor:

- Dry Ice, 1 slab
- Gloves, heavy thermal-insulated
- Chisel
- Aquarium, 24-gal
- Pitchers, plastic, for water (2)
- Candle bent at a right angle
- Cigarette lighter
- Water, hot
- Bubble wand
- Bubble solution
- Bottle, plastic, with squeeze spout in lid
- Balloon, 12"
- Rubber Band to secure balloon to bottle spout
- Film Cans, plastic, about 6
- Bucket or Large Plastic Tub to dump leftover water & dry ice

Prep Work:

- Buy Dry Ice on morning of class, solid blocks (about 25 lbs per class); keep in picnic cooler
- Chop most of dry ice into chunks, small enough to fit into plastic cups. (Keep at least one piece whole for demo)
- Heat water, about 2.5 gal
- Mix bubble solution

Items needed for Students:

Consumables (per student):

- Dry ice chunk
- Cup, Clear Plastic, 16-oz
- Hot Water, about 8 oz per student
- Dish Soap (a few drops per student)

Other:

- Aluminum Bar
 - Earmuffs
-

Story Recap: “*The Leprechaun Olympics*”



Part 1:

- Leprechauns have pots of gold that they keep at the end of the rainbow.
- People can get the leprechaun's gold if they catch a leprechaun.
- The leprechauns are going to have their olympic games. Games include a race across the rainbow, and tossing long poles into the air, and tossing other leprechauns into a mud puddle.
- Each year, Mother Nature creates fog so outsiders can't see the leprechauns during their games.
- Last year, Evil Mister Fred's minions trashed the game site after the games so Mother Nature would think the leprechauns had done it.
- Now Mother Nature refuses to make fog to hide the leprechauns.
- Evil Mister Fred is flying on his vacuum cleaner looking for the leprechauns so he can capture them and get their gold.
- The leprechauns call Jack and Jill for help.
- Jack & Jill try to persuade Mother Nature to help, but she refuses.

**Ending:**

- Jack & Jill order ten thousand pounds of dry ice from the Acme Store of Everything and pour it into the mud puddle to create fog.
- Evil Mister Fred starts vacuuming up the fog.
- Evil Mister Fred couldn't see very well in the fog, and he crash-landed in the mud puddle.
- The mud covered Evil Mister Fred, and the dry ice turned it into a hard mud shell around him.

Transcript: Intro

We're going to do some experiments with something that's kind of either really hot or really cold. It's made out of the same stuff that's in our breath when we breathe out. It's the same stuff that makes the little bubbles in soda pop -- bubble, bubble, bubble, bubble. And it's the same stuff that plants breathe to stay alive. Yeah, and it's the same stuff that's blamed for global warming. Carbon dioxide.

It's so cold that it's 109 degrees below zero. If there was a steel pole that was this cold and you walked up to it and licked it, your tongue would get stuck to the pole. It would immediately freeze the water on your tongue.

But you notice it's not dripping. No wetness. Carbon dioxide doesn't drip. It turns straight from a solid into a gas, and it skips the whole drippy part. And they call that sublimation.

If I touch it with my hand, will my hand freeze? *[Brushes hand along edge of the slab of dry ice.]* In fact, you can pet it like a cat, and your hand doesn't stick, because it's trying to turn into a gas, and it pushes your hand away. However, the hand with the glove *[the hand holding the slab]* is getting really cold. So I'm going to get a double layer of gloves so that my hand doesn't freeze. You can see there's already frost on that glove. If you press a hot dog on it, it takes about 12 seconds before the hot dog is frozen on the surface.



Carbon dioxide doesn't drip.

I'm going to bring it by, and if you want to pet the cat, you can pet the cat. Don't grab the cat, because cats don't like to be grabbed. *[Students take turns stroking the slab.]*

[Student asks why it doesn't make your hand cold.]

Well, it takes 12 seconds. It has to grab onto it and hold it for 12 seconds. Twelve seconds is one thousand one, one thousand two, one thousand three, one thousand four, one thousand five, one thousand six, one thousand seven, one thousand eight, one thousand nine, one thousand ten, one thousand eleven, and one thousand twelve. If you held it that long, then the skin on the tip of your fingers would be frozen and you'd say, "Ooooh, that hurts!" And then when they thaw it out, it would look as if you had actually touched something that was hot. It would be all red and look like you had burned yourself.



Students get to "pet" the dry ice slab.

We're going to put the dry ice in here *[places slab in aquarium tank]* and lean it against the windows so you can see it. Should we do the story first or the demonstrations first?

[Students: Story!] Okay, we'll do the story first.

Story: "The Leprechaun Olympics"

Do you know what a leprechaun is? Little short guy, and he hangs around rainbows, and he stores his treasure at the end of the rainbow. So we need a rainbow.

Rainbows have red, right? There's some red. And it has some orange; there's some orange. And it has what other colors? Yellow, okay. Green? Okay. And then blue. And then purple. There it is. Now we need some land -- let's have some red land, like that. And maybe it should have some trees. *[Draws some large trees, then successively smaller ones.]* There's a tree far away. This is a tree that's even further away. Here's a tree that's so far away you can hardly see it. It's way off in the distance.

And every year, the leprechauns . . . let's draw a leprechaun. A leprechaun is probably green. They've got a hat with a ball on the end, they have a big head, and we'll give him some big ears. They've got a smile because they're always up to no good. And they have big pants and little suspender things. And they've got feet with curled-up toes, like that. And little tiny hands. There's a leprechaun. And he's polka-dotted. There.

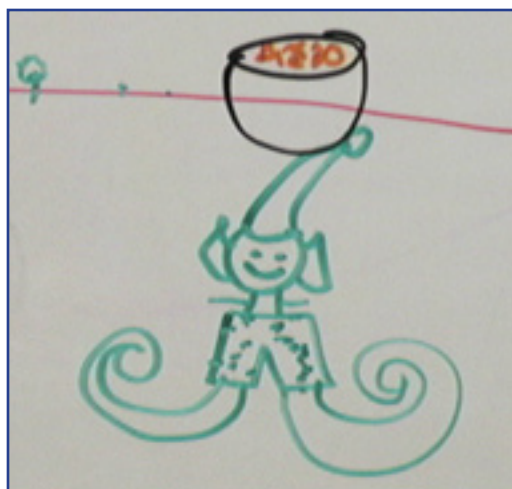
The leprechauns usually have a pot of gold. And Evil Mister Fred is always trying to steal their gold. All you have to do to get a leprechaun's gold is catch the leprechaun. And then you say, "Oh, leprechaun, leprechaun, I'll let you go if you give me your pot of gold." And the leprechaun says, "All right, here you go." He gives you a pot of gold and then he runs away.

And Evil Mister Fred is hovering over in his vacuum cleaner, always searching for leprechauns because he wants their gold. And to make his eyesight better, Evil Mister Fred called the Acme Store of Everything and he ordered some binoculars. Like that. That's some binoculars. So the leprechauns always have to hide under bushes and under trees and run real fast so that Evil Mister Fred can't catch them. And they have all of their gold stored at the end of the rainbow.

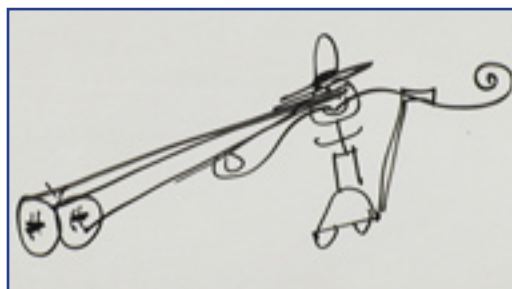
Well, every year the leprechauns have their leprechaun olympics. In the leprechaun olympics, they do all kinds of games to see who's the best at things. One of the games is the Rainbow Run. All the leprechauns line up on one side over here, and when the starter gun goes off -- bang! -- they run up the rainbow and down the other side. And here's the Finish line over here.



The leprechaun's rainbow.



A leprechaun and his pot of gold.

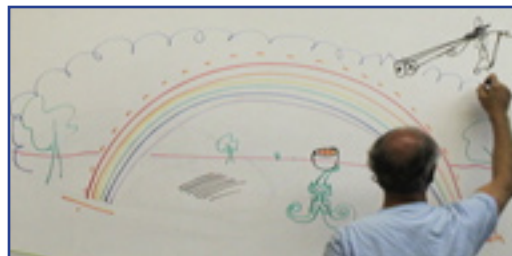


Evil Mister Fred and his binoculars.

Another leprechaun game is, they take a telephone pole and throw it into the air as high as they can. And then they run around and catch it. And whoever can keep the pole in the air the longest is the winner. So there's a bunch of telephone poles that they have to throw into the air.

Another leprechaun game is, they'll grab another leprechaun by the top of his hat. Their hats stay on tight. And they'll swing him around in circles and throw him as far as they can. And there's a great big mud puddle out there that they aim their leprechaun at. And whoever can throw the farthest wins the game.

Now, while they're doing these games, people can sneak in and grab them, and then *[the leprechauns]* have to pay money to get free again. So every year, the leprechauns call Mother Nature -- brringgg! "Mother Nature, we're having our olympics this year, and we need some fog, lots of thick, heavy fog, so no one can see us while we're doing our games." And every year, Mother Nature provides a big blanket of fog so that no one can see what's going on. And the leprechauns can concentrate on their olympics.



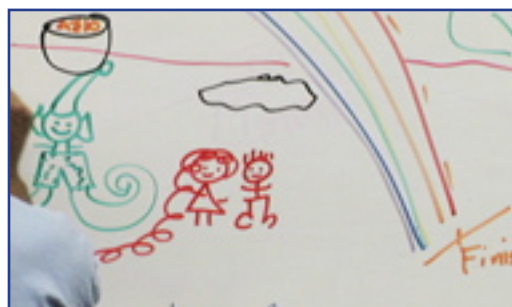
Mother Nature usually makes fog to hide the leprechauns.

Well, Evil Mister Fred has been planning this for a long time. The last year they had their olympics, Evil Mister Fred sent his minions out after the olympics were all over and everything was cleaned up. Evil Mister Fred's minions went out and they threw trash everywhere. They broke branches off of trees, they ripped grass out of the ground, they polluted the stream, they put garbage everywhere you could put garbage. And then when Mother Nature came by, she saw this huge mess. And she said, "Why, those little leprechauns! Look at this mess!" And Mother Nature had to clean up everything herself.

Well, this year, when the leprechauns went to Mother Nature to ask for fog, you know what she said? "Not a chance. Last year you left it all messed up. No fog this year." The leprechauns said, "What? We cleaned up last year." But Mother Nature said, "No, you didn't. Everything was a disaster. No fog!" And the leprechauns went, "Uh, now what?"

So they called Jack and Jill and said, "Jack and Jill, we've got a big problem. Last year we had all this fog. We cleaned up, but somebody must have messed it up after us. Now Mother Nature won't give us any fog." And Jack and Jill said, "Well, we'll come over and see what we can do."

Jack and Jill went and talked to them, and they talked to Mother Nature, but Mother Nature said, "Not a chance. No fog for you guys." Now, if you were Jack and Jill, what would you do?



The leprechauns called Jack and Jill for help.

Imagination and Brainstorming 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 . . .

Demos & Experiments

Demo #1: Candle Flame

Now we can do some experiments. [Stands next to aquarium tank, which has a slab of dry ice inside.] Okay, I'm going to blow into it and see what it does. [Blows into tank, and the fog coming off the slab increases a bit.] What was that stuff coming out of my mouth? Doesn't it look like fog in there? Well there's water vapor in your breath when you breathe out, and the water vapor, if it's gets cold enough, turns into -- looks like smoke, doesn't it? It's really fog. So I'm making a little bit of fog in there. Let's put in there, maybe, Jill. We'll put Jill down in there, and we'll tie her to some railroad tracks. And we'll put Evil Mister Fred coming along with a train -- chugga, chugga, chugga, chugga -- saying, "Mwah, hah, hah, hah, gonna run over Jill." And then we'll have Jack standing up here saying, "Never fear, Super Jack is here. I'm going to jump down there and rescue Jill before Evil Mister Fred chops her up with a choo-choo train."

So we need a Jack of some sort. Here's a Jack [holds up a candle]. Remember we talked about flames and how they need three things to stay alive? [Lights candle.] Well, Jack breathes oxygen, and he eats wax, and he's got heat for the flame to stay alive. He could freeze to death if it got really cold, or if we took away his oxygen, he would die. Jack is up here [holds candle just above the rim of the tank], and he's going to jump in and rescue Jill. Will Jack succeed?

Okay, he's going to jump down. Watch Jack. Ready, get set, go! [Lowers candle into aquarium, and the flame goes out a few inches below the rim.] Aww, poor Jack. He died before he hit the ground. Let's light him again. We'll give him another chance.

Okay, Jack, you'd better do it this time or Jill's going to get run over. Okay, here goes Jack. [Candle again goes out a few inches below the rim.] Ohhh, not again -- kerplunk. And Jill says, "Oh, man, do I have to do everything around here?" And she ripped up one rail, and she ripped off the other rail, and Evil Mister Fred's train crashed down into a ravine. She jumped with Jack onto the rails and up to the top and saved the day.

Why did Jack die? [Student: There's no oxygen.] Oh, watch that flame. You see what that flame did?



The candle flame goes out as it's lowered into the aquarium.

You're right, there was no oxygen down there. *[Lights a cigarette lighter and lowers it into the tank.]* Here he goes -- aaaaah! See, the flame got shorter and shorter and shorter? The carbon dioxide must be about here because the flame couldn't stay alive down below. I try to light it -- nothing. It looks good up there, and . . . *[raises and lowers lighter, and the flame gets larger and smaller]* disappears.

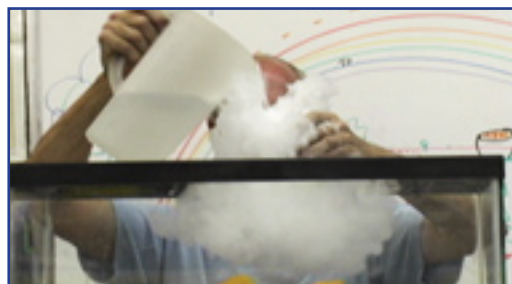
Demo #2: Sloshing Fog and Bubbles

Well, we want to see that a little bit differently. We're going to add some clouds. We'll put some dry ice in a cup and we're going to hold it here *[just below the rim]*. And we're going to pour hot water on the dry ice. If I blow into it, do you remember what happened when I blew into the tank? Watch now. *[Blows into the cup of dry ice, and fog forms.]* Lots of fog, huh? Here, you can blow. *[Holds the cup in front of a few student in turn so they can blow on it.]* Ah, she fogged her face. Ah, that's good -- you fogged your face.

[Begins to pour warm water into cup while holding it just above the tank.] Okay, here comes more moisture. *[Fog flows out of cup and spreads out, hovering near the top of the tank.]* Now we have some clouds. Can you see the clouds? What if I want ground fog? I'll put that down there. *[Places cup in bottom of tank.]* Now there's ground fog. And in between the clouds and the ground fog, is me. *[Bends down so students can see his face through the middle part of the tank where the air is clear.]*

[Removes cup from tank and places it inside a clear plastic pitcher.] I'm going to put this out here so you can watch it. *[Returns to the aquarium.]* Now suppose there's an earthquake. *[Slides the wheeled cart back and forth with the aquarium on it, and the fog inside the tank sloshes around.]* Oh, look at that. That carbon dioxide is heavy stuff. It sloshes like water in your bathtub. Can you see it go slosh?

Now suppose you're in your bathtub and the water is sloshing back and forth. I'm going to put some of you in there. *[Takes out some bubble solution and starts blowing bubbles, then uses the bubble wand to place them in the tank.]* There's one of you. Let's see if we can get a few of you in there. *[Students: Wow, they float! They float because the carbon dioxide's fluffy.]* Yeah, it's kind of dense stuff. If you wiggle your finger by a bubble, it wants to follow your finger. *[A couple of bubbles merge into a larger one.]* Oh, look, this bubble ate that bubble! And they're floating on the heavy carbon dioxide. The carbon dioxide's kind of heavy, bubbles can float on it, you can make fog, it can do something else that you're going to find out in a minute.



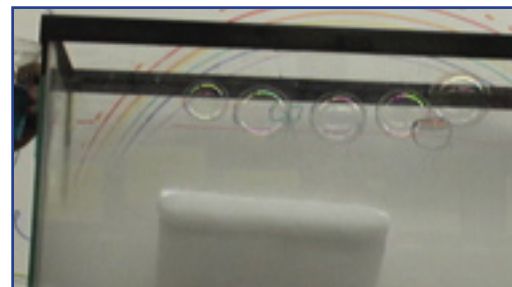
The fog floats above the carbon dioxide.



Putting the cup at the bottom of the aquarium creates ground fog.



The fog sloshes like water.



Bubbles float on top of the fog.

Demo #3: Exploding Balloon

But first, we're going to put some dry ice into this squeezy bottle. *[Puts pieces of dry ice into the bottle and replaces the lid, which has a long narrow spout on it.]* And I'm going to put a balloon on top of the jar. *[Attaches an uninflated balloon to the opening of the spout with a rubber band.]* This is the lid of the jar and it's got a tube with a hole in it. You have a choice. You can either make it go ka-boom or not make it go ka-boom. How many people don't want ka-booms, raise your hand. How many like ka-booms? If you don't like ka-booms, go get some earmuffs.



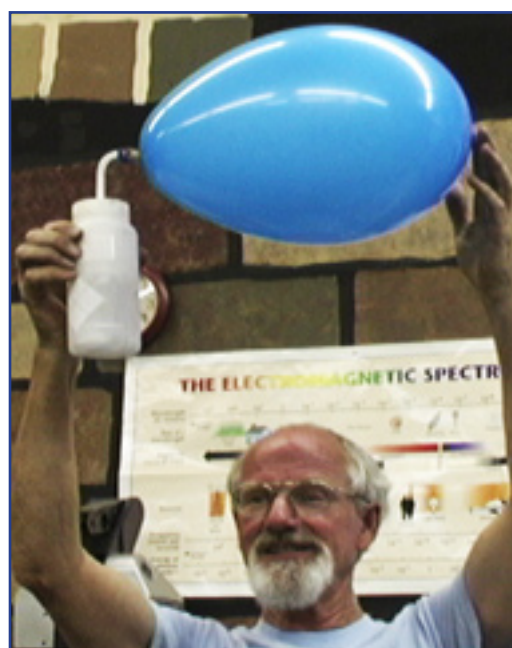
Attach balloon to spout on lid.

When I was in high school, our chemistry teacher had a great big piece of dry ice left over. And he had an old fashioned freezer, and he put the dry ice in the freezer. And he closed the door, ka-boomf. And it was a really good freezer. The next day was Saturday, and the principal called him at home and said, "Hey, Mister B., we have a problem. Come over to the school." *[Holds up squeezy bottle with balloon attached.]* Here's his freezer, pretend. And when Mister B. got there, he said, "Oh, look, somebody broke all the windows in my classroom!" And he ran inside, and the desks were all tipped over, the lights were ripped out of the ceiling, and the door was no longer on the freezer. It was stuck clear across the classroom in the other wall. He said, "Uh, oh. What happened?"

[Holds up bottle.] Well, now, this is like his freezer. What's making this balloon get bigger? Carbon dioxide. Pressure, huh? It's not going very fast, but it just keeps going and going and going. We want it to go fast. So, what should we do to make the balloon puff up faster?

[Student: Put hot water in it.] What a good idea. Put hot water in it. And we'll see what happens. *[Pours hot water into the bottle and it starts fogging immediately.]* Now we'll put our lid back on. *[Replaces the lid with the balloon on it.]* And our balloon is puffing up faster than before. This is kind of like Mister B.'s freezer, except in high speed. The pressure in the freezer kept getting more, and more, and more. Is it going to pop soon? We'll wait and see. I'm going to walk around, and if it pops over your head you get extra points. *[Walks around class, but balloon doesn't pop.]* Oh, it's not popping. Is there something wrong with this balloon. No? It's a giant bottle? Is it an unbreakable balloon, maybe that's what it is? It'll never, ever pop. It's really getting big. I don't think it's ever going to pop.

[Places balloon on top of aquarium.] I'll just rest it right here and we'll warm it up a bit. *[Lights cigarette lighter and brings it close to the balloon, making it pop.]*



Carbon dioxide inflates the balloon.

[Fog continues to rush out through the spout.] What's that stuff that's coming out? *[Lets students feel the cold blast.]* That's what happened with Mister B.'s freezer. The dry ice made it explode. Nowadays they make freezers with no latches on them. They can't blow up.

Experiment: Singing Metal, Bubbles, and Ice Eggs

Now, you guys are going to get to do an experiment. We're going to put dry ice in a cup, and we're going to give one to each person. When you get it, you can blow in it and make your face fog up. And then we're going to give you some special metal bars. The metal bars have been through the Juilliard School of Music and learned how to sing. When you get your bar, you're going to try to make it sing.

[Instructors pass out cups with dry ice and aluminum bars.]

[After awhile, Instructor pours hot water into each cup so fog pours out and spreads across the table.]



Student feels a cold blast of fog.



Aluminum bar makes a screeching sound when it touches dry ice.



Adding hot water creates fog.

[Several minutes later, Instructor pours a few drops of dishwashing liquid into each cup, and suds bubble out of the cup.]



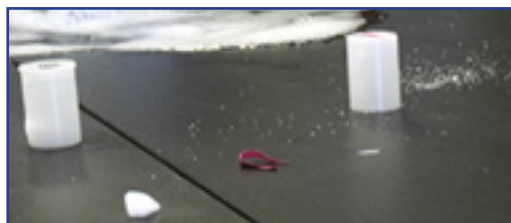
A few drops of dish soap makes the dry ice blow bubbles.



Checking the temperature.

[When the bubbles start to slow down, Instructor drops another chunk of dry ice into each cup. Then Instructor then uses an infrared thermometer to check the temperature of each cup. Most of them are 37 degrees.] How much dry ice is it going to take before your cup is frozen solid?

[After awhile, Instructor places a few plastic film cans on the table with a piece of dry ice inside and the lids firmly in place. Students watch as the lids spontaneously blow off.]



Film cans with dry ice inside.

[Eventually, the dry ice chunks in the students' cups form shells of water ice around them, and the Instructor takes them out of the cups, one at a time.]

Now we have an Easter egg here. It's really slippery. When you add soap to ice, talk about slippery! Now, we're going to break your Easter egg and see what's inside. Are you ready?

[Instructor breaks the ice egg open by hitting it against the tabletop, exposing a chunk of dry ice inside the water ice.] There's your dry ice piece. It left a hole inside. *[He puts the dry ice pieces back in the cup, leaving the water ice on the table for the student to examine. This is repeated for each individual student.]*

Okay, we need to clean up the table. Let's put as much as we can into the cups first. *[Instructor puts a large bucket on the table and dumps the contents of each cup into it, then passes around large towels to wipe off the tables.]*



Instructor takes an ice egg out of the cup.



Instructor points out the chunk of dry ice inside the egg of water ice.

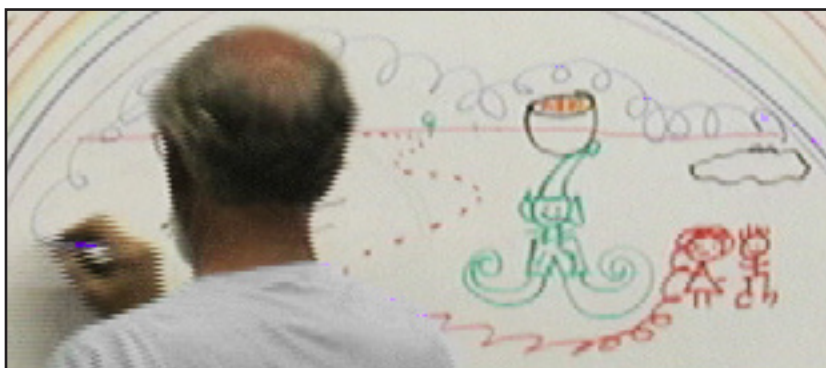


Everything goes into the bucket.

End of Story

**** DO NOT * present this part of the lesson until after the experiments!***

So the leprechauns didn't have any fog to hide them during their leprechaun olympics. And they called Jack and Jill. Evil Mister Fred was always flying around on his vacuum cleaner, trying to catch one so he could get the pot of gold. And Jack and Jill said, "We've got to do something. We need fog right now." So they called the Acme Store of Everything and they ordered ten thousand pounds of dry ice. And they threw the dry ice into this big old mud puddle. And it started to make fog, lots and lots of fog. And it was covering up everything. And the leprechauns all said, "Yeaaaayyy!"



The dry ice in the mud puddle made fog that surrounded the leprechauns.

And Evil Mister Fred up above said, "Boooo!!" because he didn't want anything covered up with fog. And he was trying to suck up the fog with his vacuum cleaner. He was zooming around going zzzhhh, zzzhhh. And Jack and Jill kept adding more and more dry ice to the mud puddle. And Evil Mister Fred couldn't really see too well as he was going around trying to suck up all this fog. And he zoomed down to get a bunch of it, and

he crash-landed in the mud puddle -- ka-boom!! And the mud went up into the air and landed on Evil Mister Fred, and then the dry ice froze a shell of mud on Evil Mister Fred. And they had their whole olympics, and everybody lived happily ever after, except Evil Mister Fred.

End of Lesson

If you have questions about this lesson, please ask them through the online [Teacher Support Forum](#) on our web site.