



Teacher's Guide for:
Candle in a Jar

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 storytelling section is taken from a demonstration-only version of the lesson that appears as a free video on our web site under the title "How Gases Change Size."

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Title Page of Video

Candle in a Jar
A Rock-it Science Lesson
Filmed June, 2009

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Intro Quick Recap

Lesson Intro: Flames are Made of Water

- When you blow your breath on a cold window, you can draw a face on it because there's water in your breath.
- Whenever you burn something, it makes two things: carbon dioxide (like dry ice) and water.
- Teacher uses a propane torch to "draw" a face on the big Van de Graaf generator's ball by creating moisture on the surface. (Face may also be drawn on a piece of glass or a mirror.)

Demo: Crunch a Soda Can

- Put some water in an empty soda can.
- Hold it over a propane torch until the water turns to steam.
- When water turns to steam, it gets eight hundred times bigger, and when it condenses it gets eight hundred times smaller.
- There's also air in the can, and the steam is going to push the air out.
- Turn the can upside down and plunge the top part into cold water.
- The can crushes itself because the steam turned back into water and shrunk eight hundred times.



Experiment Quick Recap: Candle in a Jar

- Each pair of students gets an aluminum roasting pan with about an inch of water in it, a large glass jar, a rounded styrofoam block with holes drilled in it to hold birthday candles, and one candle to start.
- Instructor lights the candle, lets it burn a few seconds, then student places the jar over the candle. (Students are advised in advance NOT to move the jar after it's been placed over the candle.)
- Instructor uses a permanent marker to mark each jar where the water has risen inside it.
- Students repeat the experiment with two, four, and eight candles. Each time, the Instructor marks the new water level.
- As a demonstration, the Instructor lights one hundred candles and places a jar over them. The water level rises only a little higher than it did with eight candles.
- Burning up the oxygen isn't sufficient to account for the water level, because the water rises much higher than the proportion of oxygen in the jar. The water also rises because of hot air shrinking, water vapor cooling, and carbon dioxide absorbing.



Equipment List: "Candle in a Jar"

Items needed for Teacher:

- Propane Torch
- Empty soda can
- Metal strap clamp and holder for soda can
- Clear plastic tub
- Water, about 5 gal.
- Plastic cup filled with 100 birthday candles (This could also be a cut-off plastic bottle.)
- Markers, permanent, in four colors
- Bucket, 5-gal

Items needed for Students:

Consumables (per 2 students):

- Birthday Candles (8 per pair of students)

Other:

- Foam Candle Holder, 2" diameter, with 2" Metal Washer on bottom and (10) 1/4" holes for candles
- Large Aluminum Foil Roasting Pan (1 per 2 students)
- 1-qt canning jar (1 per 2 students)

Prep Work:

- Slice 2" diameter styro-foam tube into 2" lengths for candleholder.
- Drill ten 1/4" holes in foam.
- Glue 2" metal washer on bottom of foam
- Glue 100 candles into plastic cup



"Birthday Cake" -- side view



Top view

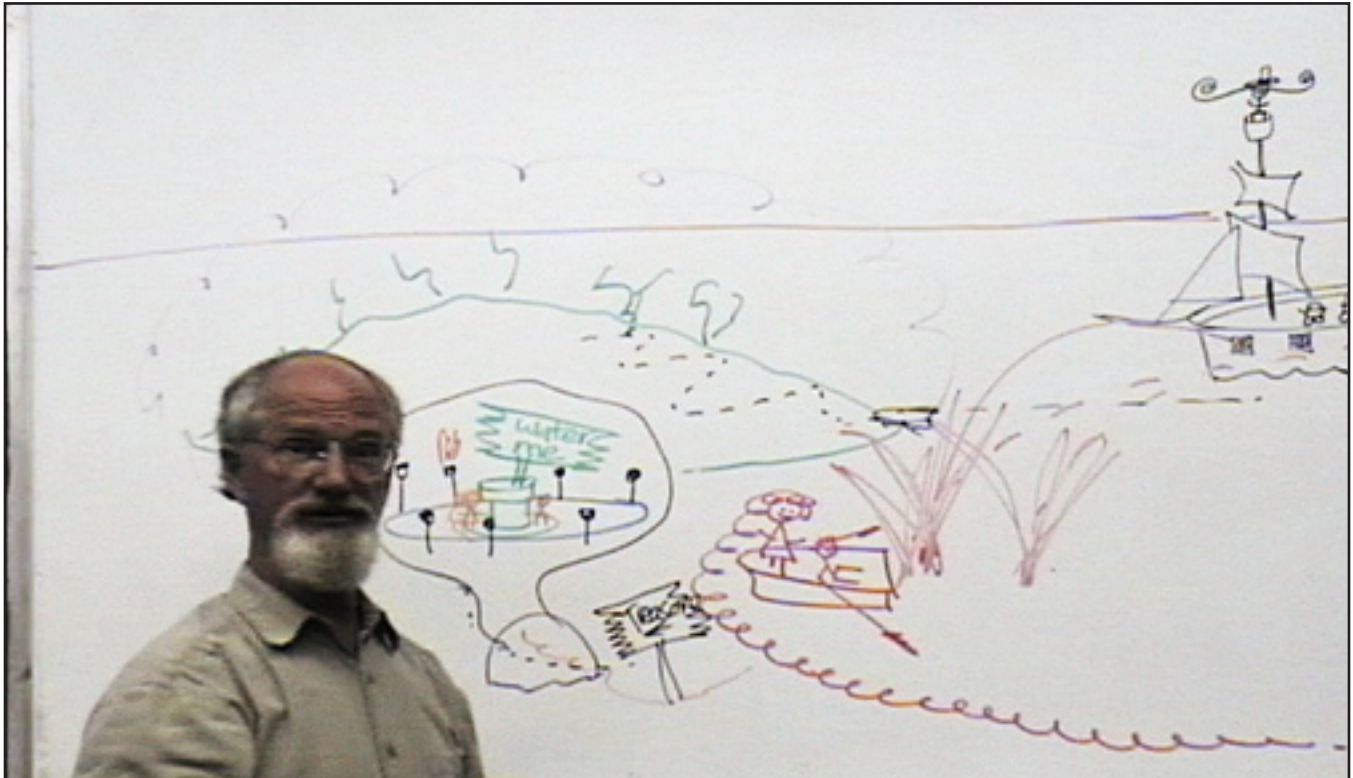


Bottom view



Plastic Cup with One Hundred Candles

Story Quick Recap



Part 1:

- Evil Mister Fred had accidentally turned his mustache into a tv antenna, and it was driving him crazy. He headed out to sea in a pirate ship to get away from the tv transmissions.
- Jack and Jill had learned that their great-great-great-great-great-great-grandfather was the Jack who had planted the magic beanstalk in the old story and had gotten riches from the giant. He had supposedly hidden those riches at Beanstalk Island, but nobody knew where it was. Jack and Jill went off in their rowboat to look for it. They found it far out at sea, hidden in fog.
- Just then, Evil Mister Fred turned up and started shooting his cannon at Jack and Jill.
- Jack and Jill jumped out of their boat and swam underwater, where they saw a sign that said, "Treasure," and the opening of an underwater cave. They swam through the opening and came up in a cavern under the island.
- There was a lake in the cavern with a small area of dirt in the center. On the dirt was a giant flower pot. Around the edges there were torches, and Jack and Jill lit one. They saw a sign on the flower pot that said, "Water Me." They also noticed that the water level in the lake had risen a little bit after they lit the torch.
- Meanwhile, on the outside, Evil Mister Fred and his minions had rowed to the island and were starting to dig for treasure, right above the cavern where Jack and Jill were.
- Jack and Jill need to find a way to get water into the flower pot.

Story Quick Recap (cont.)



Ending:

- Jack and Jill lit up all of the torches, which made the water level rise so high that it overflowed into the flower pot. Immediately, a giant beanstalk started growing out of it.
- The beanstalk burst upward with so much force, it blew off the top of the island. Evil Mister Fred and his minions, who had been right above it, went flying clear over the horizon.
- Jack and Jill got carried upward on the beanstalk itself. It sprouted branches and leaves and finally bean pods. The pods were gold, and they were filled with gold coins and jewels.
- The beanstalk kept growing until it tilted over right where the pirate ship was. Jack and Jill loaded the ship up with their treasure and headed home.

Transcript: Introduction

Flames. What are flames made out of? Fire. What would you say if I told you it's blue because it's made out of water? You'd say, "You're crazy." Well, have you ever blown your breath on a cold window? You go, whoo, whoo, whoo, whoo, whoo, whoo, whoo, and draw a face on the window? Why does it make a face on the window? There's water in your breath. Remember when you blew on the dry ice and it made fog? And if water in your breath condenses on the window it makes fog. Well, whenever you burn something -- doesn't matter what you burn -- whether you burn a candle or a flame or a fire in your house -- it always makes two things. The first thing is carbon dioxide that you can make dry ice out of; and thing number two is water vapor. This is making water vapor. And you say, "No, it's not!" So now I have to prove it, right? Okay, so what I'm going to do is find a window and point this at the window and draw a face. Except there are no windows. Oh, man! What shall we do? How about this big ball [*points to giant Van de Graaff*]? Can we draw a face on the big ball? We could try. [*Moves flame over the surface.*] Here's an eye. Does that look like fog? Here's an eye. Here's a nose. And here's the mouth. Yep, there's the water vapor from the flame. You can see it on the big ball.



Drawing a Face

Demo: Crunch a Soda Can

Now, in our experiments today, we're going to be using some candles to make water vapor. But first we're going to cook a soda can. Now, I need to put a little water in our soda can. Let's put in four tablespoons and see how long it takes to boil it. Listen. Hear it doing anything? Now, the can has water in it. You saw me put water in, right. What else is in there with the water? Air, okay. Now, pretty soon it's going to make steam, and the steam is going to come out. And the steam is going to push the air out of the can. When steam condenses, what does it turn into? Water. Did you know that when you turn water into steam, it gets bigger by about eight hundred times? Ooh. When it turns back into water, it gets smaller by about eight hundred times. Now, we have to let it be steamy for awhile, because it's got to push the air out of the can. So we're letting it steam. Steam, steam, steam, steam, push, push, push, push. The air molecules



Heating the Water



Crushed Can

are in there saying, "Stop. Don't push, don't push." Imagine everybody in a big store and along come a bunch of bats, and they scare everyone and they all have to leave. Pretty soon the bats push out everybody. And the store's empty of people, but it's full of bats. And they're all flying around, but they don't bump into each other because they've got sonar.

And that's pretty steamy. What I'm going to do is turn it upside down and put it in the water, but not all the way in the water. Just the top portion of it. Five, four, three, two, one! [*Turns can upside down in a transparent bucket of water and it crumples.*] Did you hear that? Look at the can. It scrunched itself. That's pretty scrunched. The steam turned back into water, shrunk eight hundred times so fast that it crushed the can.

Story: "Beanstalk Island"

Once upon a time Evil Mister Fred was traveling far, far out at sea. It seems that he'd been experimenting late one night and accidentally turned his mustache into a very sensitive antenna. And in the city areas, he picked up all the tv shows, the radio shows, everything under the sun, came in on his mustache and into his head, and it was driving him crazy. So he took off in his pirate ship to see if he could find a place where he could have peace of mind, and at least go out and try and get some treasure from other people.

In the meantime, Jack and Jill had learned from their Grandma that their great-great-great-great-great-Grampa Jack was the one who had planted the beanstalk and went and got all the riches from the giant. And he'd stored all those riches at Beanstalk Island. But nobody ever knew where Beanstalk Island was. And Jack and Jill had taken off in their handy-dandy rowboat to try and find Beanstalk Island.

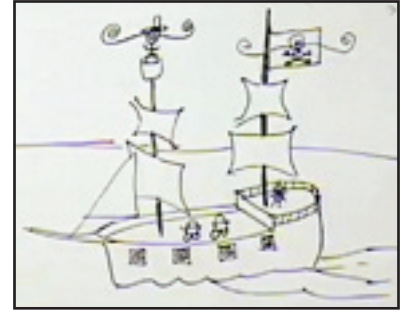
And by chance, as they were out at sea, they saw a huge bank of fog. And under all that fog they saw some green. The green was beanstalks, growing out of something, green everywhere. And they looked, and here was an island, hidden in the fog. No wonder nobody ever found it.

And who would have guessed that at that very moment Evil Mister Fred arrived at the very same spot. And he saw Jack and Jill out there, and he also saw through the fog Beanstalk Island. Everybody knew that that was the island of the riches. And Evil Mister Fred said, "Yesss!! We found it, the famous island, with all the treasure. But Jack and Jill are there. I've got to get rid of them."

So Evil Mister Fred had his minions load up all the cannons and start shooting at Jack and Jill. They were trying to sink Jack and Jill's rowboat. And when Jack and Jill saw this, they said, "Whooh! Even if they are a bad shot, sooner or later they're gonna hit our rowboat and that'll be the end of us!"

So Jack and Jill dove into the water and started swimming for their lives. As soon as they entered, they looked down and what did they see? A sign under the water that says "Treasure," with an arrow. And the arrow pointed right at the opening of a cave underwater.

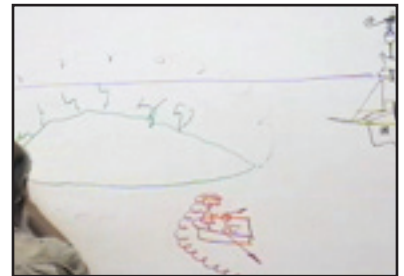
So Jack and Jill swam down into the cave. They only had to go a little ways when they popped up under the island in this hidden chamber. (We'll just draw the whole chamber here like this.) And the chamber had water in it. It looked like a small lake there. And when Jack and Jill



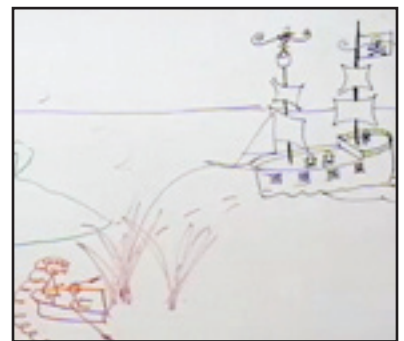
Evil Mr. Fred's pirate ship



Jack & Jill's rowboat



Beanstalk Island in the fog



Minions shoot cannonballs



"Treasure" sign at cave entrance

popped up and they got their breath of air back, in the middle of the lake they saw a pot, like one would grow a plant in, with a little bit of ground around it. And the pot also had a sign. And the sign said, "Water me."

There wasn't very much light in this room, but Jack and Jill saw that around the edges of the lake that was in there, there were torches. But they weren't lit. And so they pulled some matches out of their pockets that were in watertight containers, and they lit one of those torches.

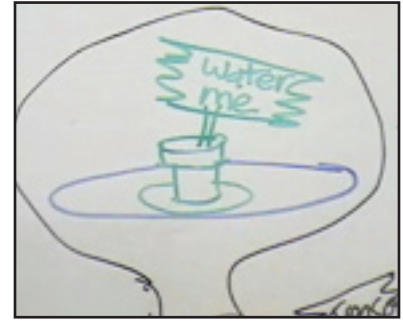
And they looked at this pot and they said, "Hmmm. I betcha our great-great-great-great-great-Grampa put this here. I wonder what this is all about."

And as they were doing this, they noticed that the water level had come up a little bit. (Let's put them there, standing on this island.) The water was now up around their ankles, whereas before it was below the surface of the thing they were standing on. (Jill's hair came all the way out.)

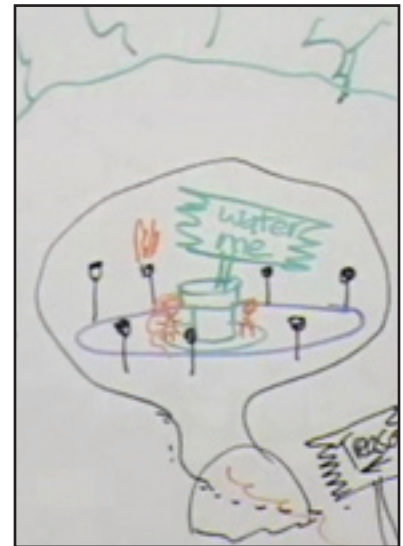
And Evil Mister Fred was on the outside. He also wanted to find that treasure. He figured he's just gotten rid of Jack and Jill because they dove overboard and he never saw them again. So Evil Mister Fred got into his rowboat, rowed over to the island with some of his minions, parked the rowboat, and started running around looking for treasure. And all he found was bean plants.

When he got near the top, he found a big "X" drawn on the ground. He says, "Ha, ha!! This must be the place where the treasure is hidden. So Evil Mister Fred had his minions start digging there, and they dug, and they dug, and they dug, while directly beneath them was Jack and Jill in the cavern, trying to figure out how to get water into the plant, to see what would happen.

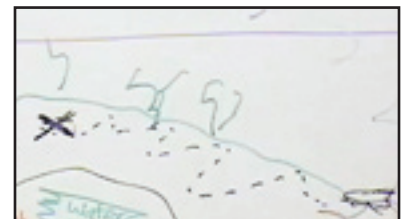
If you were Jack and Jill, what would you do to get water up into the plant?



"Water Me" sign in pot



Torches around lake



Evil Mr. Fred finds "X" on ground

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 . . .

Experiment: *Candle in a Jar*

Next experiment, we should do something, shouldn't we? Yes. For our next experiment, you're going to need an aluminum tray, one for every two people. *[Instructor passes out trays and pours some water in each one.]* And we're going to float our birthday candles on our un-birthday cake. *[Student: Is that really a cake?]* No, it's foam, with a steel washer on the bottom. It would hurt your teeth. It's got holes in it to put candles. And if we put it in the lake -- this one probably doesn't have quite enough water -- let's try it in this one. There. It almost floats. It's just right.

Now, what we're going to do is, we'll give each tub a birthday cake and a jar. What we're going to do is light your birthday candle. After it burns for a little while, one of you is going to put the jar over the birthday cake, and just leave it there. The candle will eventually get smaller and smaller and smaller, and the flame will go out. And after it goes out, you don't touch the jar. Repeat after me: "After the candle goes out . . ." *[Students: After the candle goes out . . .]* "I don't touch the jar . . ." *[Students: I don't touch the jar . . .]* "because something is going to happen . . ." *[Students: because something is going to happen . . .]* "and we want to compare the jars with each other." *[Students: and we want to compare the jars with each other.]*

[Instructors pass out birthday cakes, candles, and jars, and light the candles.] After Jen lights it, you can let it burn for a little bit and then put the jar on. *[Students put the jars over the candles.]* Look, your cake is starting to float. Did you see your cake go up? *[Student: That's because it burns up all the oxygen.]* Yeah, that's what they used to say, it burns up all the oxygen.

We're going to mark yours with purple. The water level is right there. *[Instructor marks the side of each jar where the water level has risen.]*

Okay, now we're going to give you each two candles, so you get one more candle. *[Students repeat the experiment with two candles, then with four candles, then with eight candles. Each time, the instructor marks the new water level on the jar.]*

Now, would everybody at this table go over to that table. *[Students gather around one table where Instructor performs next demonstration.]* Leave your pans there. This time, we're going to do a hundred candles. *[Instructor lights one hundred candles and places a jar over them.]* There, now we're going to compare this to one of the other ones. These are pretty close to typical. Before, the water went up about that far. And when you add more and more candles, it doesn't go up much



Foam with Candles



Putting Jar over Candles



Marking the Water Level

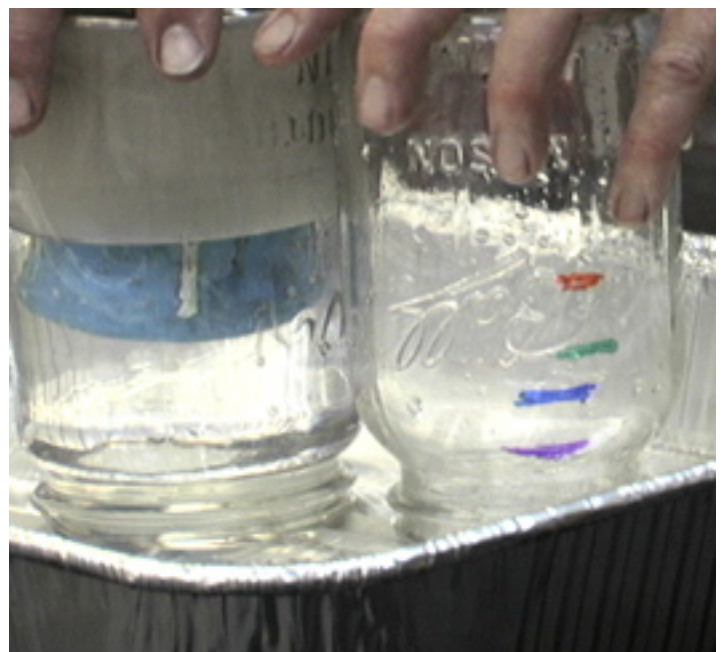
further. This is about as high as it gets. *[Student: What if you lit a thousand candles?]* It would only go up about that much. It wouldn't go much higher than that. It's about the limit. So you remember, I was telling you that flames have water in them? And when the water gets into the jar, it cools off, the water vapor shrinks and helps suck the water up from the tub into the jar.

Also, the carbon dioxide, like the dry-ice-type carbon dioxide, it also can go into the water slowly and slowly bring the water up. But there's something else that happens, too. When hot air gets cool, it shrinks, too. So hot air shrinking, water vapor cooling, and carbon dioxide absorbing, all draw this water up inside of the jar. *[Student: There's a lot of smoke in that one.]* And there's a lot of smoke. It was running out of oxygen and couldn't burn up everything.

So we're going to pull this off *[removes jar]*. Imagine Jack and Jill in a teapot. Ooh, with a bunch of flame in there -- hmmm. Now we're going to pour the water back into our big buckets.



Putting the Jar Over 100 Candles



The Water Level isn't Much Higher than Eight Candles

End of Story

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

Okay, you remember that when you had the candles under the jar, as the flame went out, the water started to go higher and higher in the jar. Jack and Jill started to realize the same thing. When they lit one torch, water started going up and up and up. So they quickly lit every torch in the whole place. And the water level went higher and higher and higher. And once the water level got up to the top of the pot, Jack and Jill were swimming in it, looking around, saying, "What's gonna happen now? And it overflowed into the dirt, and immediately something started to grow out of the dirt. And Jack and Jill said, "It's the beanstalk!"

And this enormous beanstalk just blew out of this pot, twenty feet wide, straight up into the air, hit the ceiling at about two hundred miles an hour, with such force that it burst the whole top of the island off. There was a huge exploding sound, rocks and debris, and beanstalks from the top were going everywhere.

Do you remember who was up here? Poor Evil Mister Fred and his minions were up here trying to dig for treasure. And when that beanstalk hit the ceiling, Evil Mister Fred and his minions went flying -- ahhhhhh, ker-splooosh! Clear over the horizon.

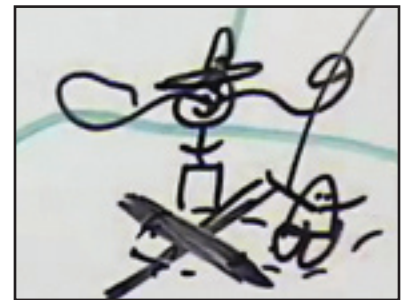
And Jack and Jill got carried away on the beanstalk itself. The leaves sprouted out and picked them up and carried them high into the sky. And then the beanstalk grew out other branches here and there, and they became heavier and heavier. And as it grew, leaves formed, and after the leaves formed, then the beans formed. The bean pods. But they weren't green. These bean pods were gold. And inside was gold coins and silver coins, and rubies and pearls, and all kinds of valuable stuff.

End of Lesson

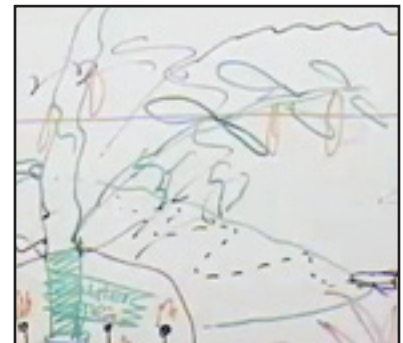
[If you have questions about this lesson, please ask them through the online Discussion Forum on our web site.](#)



Beanstalk starts to sprout.



Evil Mr. Fred & minions digging.



Beanstalk bursts through,
golden pods form.