



Teacher's Guide for:

Jacob's Ladder & Tesla Coil

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.

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Title Page of Video

(Numbers in the text are **time codes**, so you can refer back to the video.)

[00:03;09]

Jacob's Ladder & Tesla Coil

filmed July, 2009

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Releases have been obtained for all students who appear in this video, but their images should not be used publicly unless their nametags are rendered unreadable and their names are bleeped from the audio track.

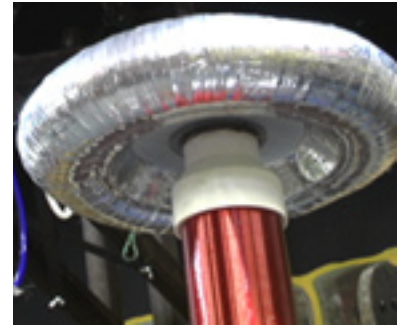
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Intro Quick Recap

Lesson Intro: Jacob's Ladder & Tesla Coil

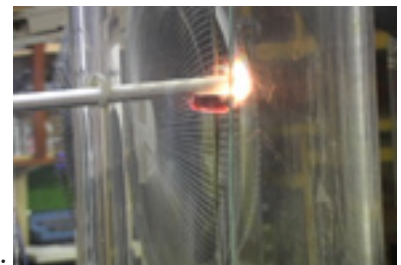
- Jacob's ladder changes voltage from 120 to 15,000.
- Tesla coil changes voltage from 15,000 to 400,000.
- Describe parts of the tesla coil.
- Capacitors are like water balloons that inflate, burst, and then inflate again.
- Voltage jumps off at the top.



Demos Quick Recap

Demo 1: Jacob's Ladder, Part 1

- Show how the spark rises between the wires.
- Insert various sticks into the chamber to see if they will catch fire.
- Wrap a piece of paper around the end of one stick so it will catch fire.
- Remove the paper and show how the scorched stick will now burn.
- Let the smoke vent before starting Part 2. *(If there's no smoke to vent, Part 2 of this demo can be done immediately.)*



Paper catches fire.

Demo 2: Jacob's Ladder, Part 2

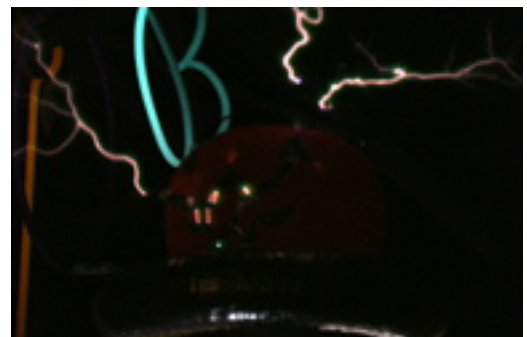
- Pump helium into the chamber.
- Show how the color of the spark changes from greenish to purple.

Demo 3: Tesla Coil, Part 1

- Quasimodo rings the bells of Notre Dame.
- One ding per two or three or seconds becomes 400 vibrations per second in the bell.
- The copper on the Tesla Coil dings 120 times per second, but at the red wires, it dings at a hundred million times per second.
- The really high voltage allows it to shoot sparks.

Demo 4: Tesla Coil, Part 2

- Demonstrate samples of monsters.
- Place monsters on top of Tesla coil, turn on power, and see sparks shoot out.



Monster on top of Tesla coil.

Experiment Quick Recap

Experiment: Make a Monster that Shoots Sparks

- Demonstrate how to use peel-off aluminum tape to attach to monsters.
- Students choose what shape they want to start out with: a 2-liter plastic bottle; a large plastic tape reel with a cup attached to the back to support it; a small plastic tape reel that sits on top of a cup.
- Place each monster on top of Tesla coil and see how it creates sparks and sometimes catches fire.



Monster from 2-liter bottle.

Equipment List: "Jacob's Ladder & Tesla Coil "

Items needed for Instructor:

- Jacob's Ladder device
- Exhaust fan
- Sticks, about 24": bamboo, wood, white plastic
- Paper, small piece
- Water to extinguish fire if needed
- Helium tank and plastic tube to fit regulator
- Tesla coil device
- Copper wire
- Sample monsters

Prep Work:

- Fill helium tank.

Items needed for Students:

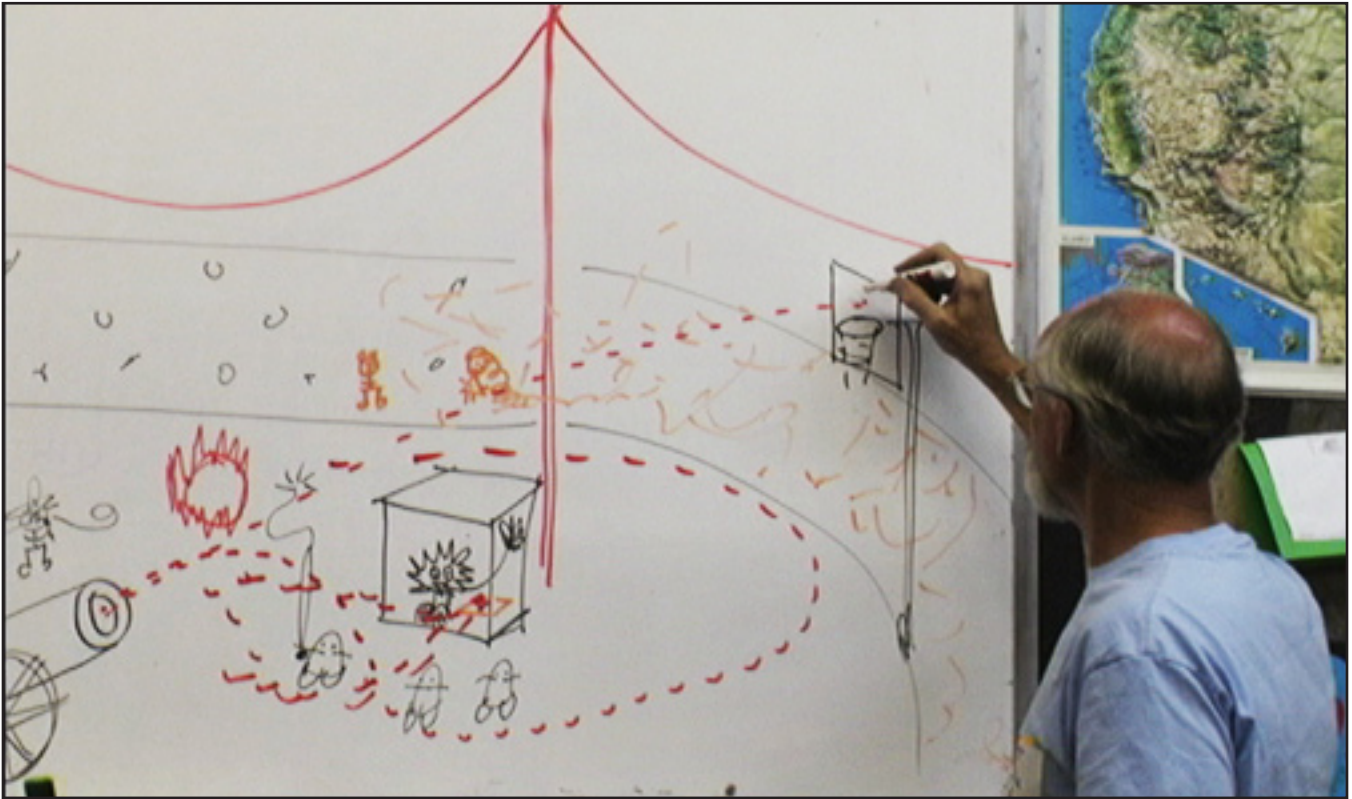
Consumables (per student):

- Students choose ONE of the following:
 - Bottles, plastic, 2-liter
 - Tape Reel, plastic, large
 - Tape Reel, plastic, small
- Cup, red plastic, 16 oz. (for Tape Reels)
- Tape, Aluminum, 2 in. with backing, about 1 ft per student
- Pipe Cleaners, optional

Other:

- Scissors
- Earmuffs

Story Quick Recap



Part 1:

- Jack and Jill are at the circus. The bleachers are full of people. Jill is having a bad hair day, and her hair is all over the place.
- The tent is held up by two metal poles.
- Evil Mister Fred is the ringmaster. There are minions assisting him.
- There's a lion in a cage with a hidden trap door in the bottom.
- The lion is supposed to come out of the cage, jump over a 10,000-volt fence, jump through a flaming hoop, jump into a cannon, get shot out of the cannon, and fall through a basketball hoop.
- Just as the cannon fires, the trap door opens and all kinds of vicious animals come out and start attacking the crowd.
- Evil Mister Fred has sewn the doors shut so the people are trapped inside.

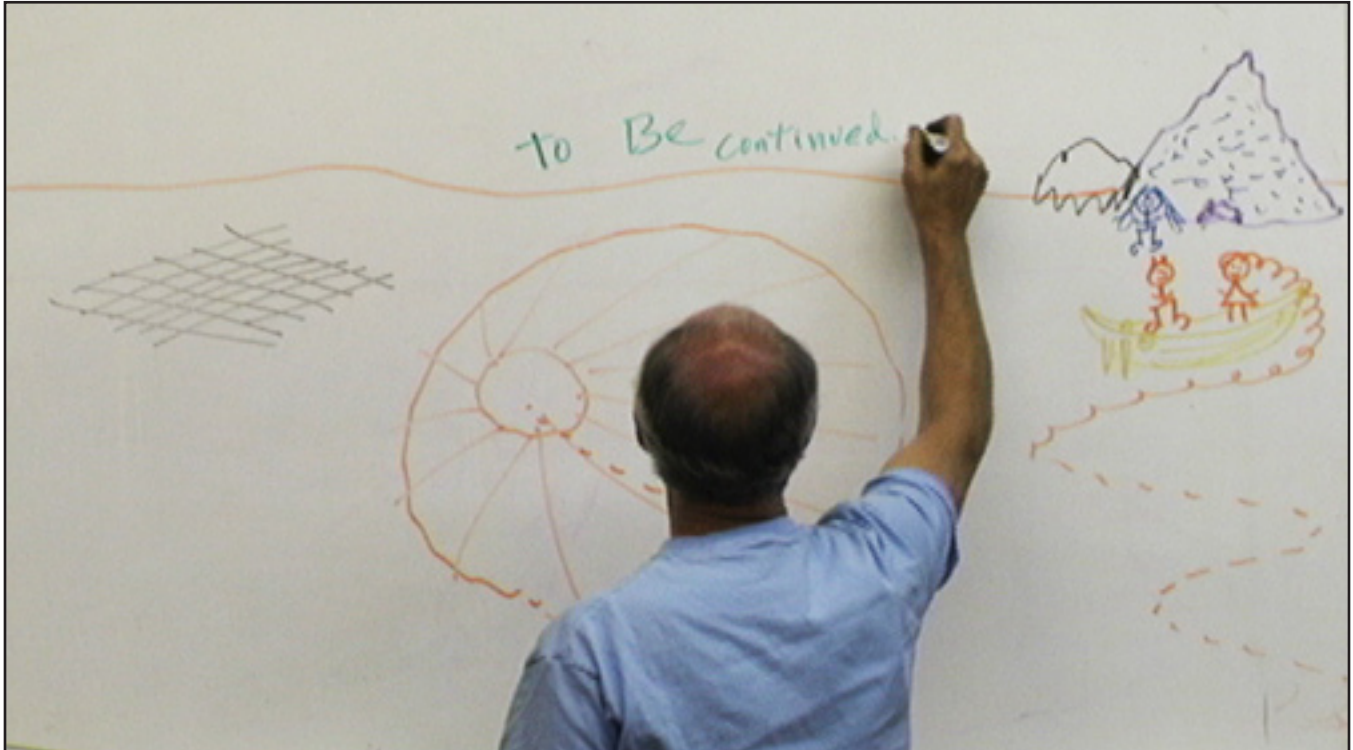
Story Quick Recap



Part 2:

- Jack and Jill wrapped Jill's hair between the two poles and ran the electricity from the 10,000-volt fence through it.
- The electricity started to arc and spark and the top of the tent started to burn. As the tent fabric started to carbonize, the electricity started making big lightning bolts between the poles.
- This terrified the animals, who ignored the people and started running around trying to find a way out.
- As the tent burned, a hole opened up, and a butterfly flew in, which terrified Evil Mister Fred, and he crashed right through the side of the tent as he ran away.
- Jack and Jill led all the people down through the trap door, which led to a mountain far away.
- The tent burned down completely, and the vicious animals escaped and started running all through the city.

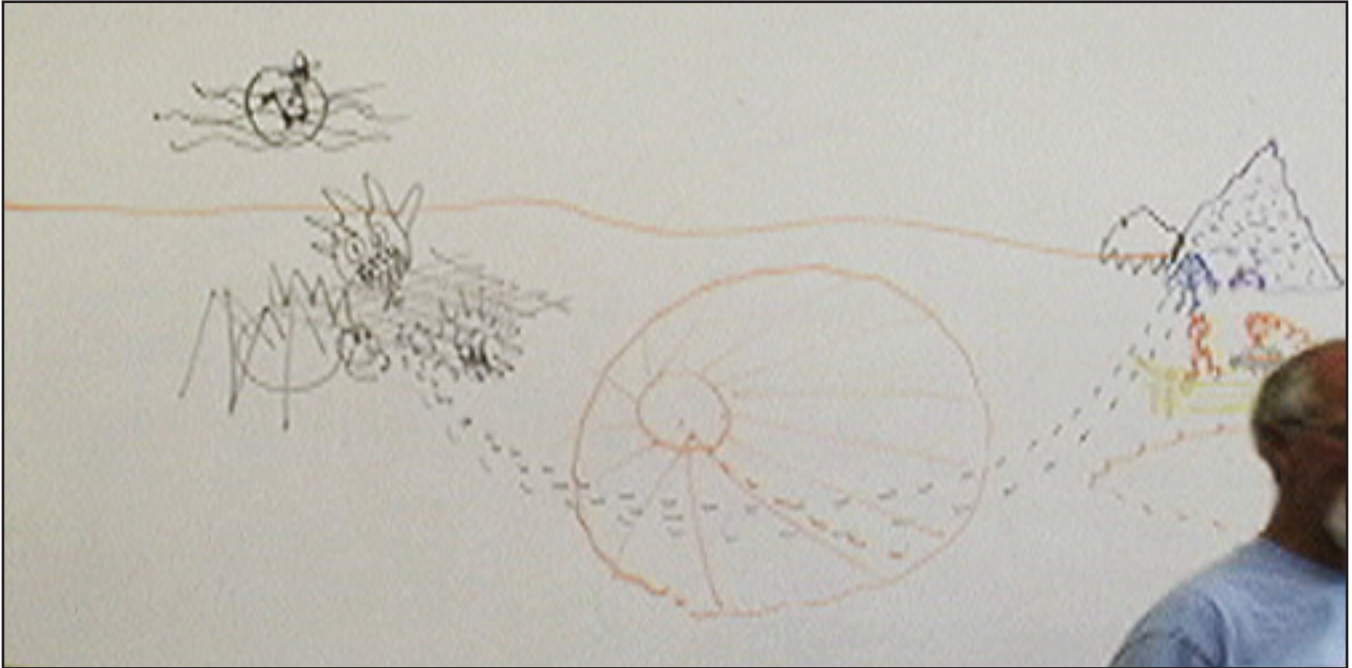
Story Quick Recap



Part 3:

- Jack and Jill are inside the mountain, standing on a giant vampire banana, with all the people around.
- They meet some people who live in the caves in the mountain. They always keep their eyes closed, but they can sense things through a bump in the center of their foreheads.
- These people can create caves using sonic waves that they transmit from their foreheads. The waves create a bonging sound, and pieces of rock fall off and start to melt, creating a tunnel.
- They told Jack and Jill that Evil Mister Fred had blown a hole in the side of their mountain with dynamite and used it as a place to hide his vicious creatures. They don't like Evil Mister Fred.
- Jack and Jill need to find a way to get rid of the animals that are rampaging through the city so people can go home again.

Story Quick Recap



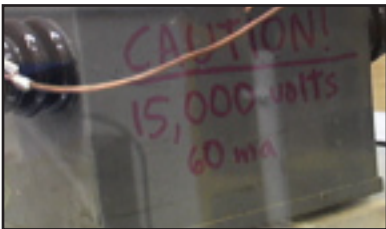
Ending:

- Jack and Jill got the weird guy to make a tunnel leading from the mountain to the city.
- Then they took a really big battery, wrapped a bunch of wire around Jill, and when they turned it on, sparks flew out of Jill's eyes and hair.
- They waited until nighttime, then crept out of the tunnel and Jill started taunting the animals, who were hiding in the houses.
- Evil Mister Fred was flying above on his vacuum cleaner, because he was afraid to be down in the city with the animals.
- The animals got angry at Jill and came out to attack her. Then Jack turned on the power and the sparks started flying.
- The animals became scared and enraged, but they were afraid to attack Jill, so they jumped into the air and attacked Evil Mister Fred instead.

Transcript: Introduction



Tesla Coil with fine red wire wrapped around it.



Transformer for Tesla Coil



Copper Pipes



Capacitors



Copper coil

[01:00:11;02] Okay, today we get to do some real Frankenstein stuff. Have you ever seen the Frankenstein movie? They have all kinds of weird things in there.

This one is called a Jacob's Ladder. A Jacob's Ladder has a box inside. The box takes electricity from the wall. The electricity from the wall is usually about 120 volts, which is bad enough. You can die with 120 volts. Then it changes it into 15,000 volts. So the 15,000 volts comes up on those two kind of bluish-greenish wire-looking things inside the tube. And we're going to see what happens when the electricity flows between those two wires. So that's Jacob's Ladder.



Jacob's Ladder with spark.

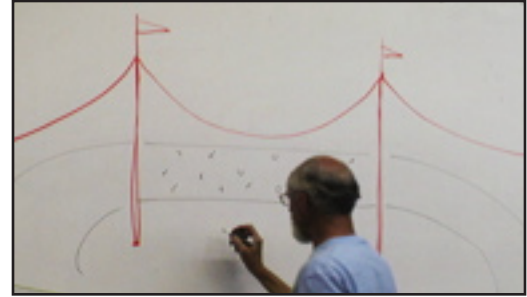
This one is called a Tesla coil. It has a box right here that's the same as the one that's in there. This one starts off at 15,000 volts. And then it goes through some copper pipes here that look like hot dogs. It jumps through the pipes. As it jumps, it charges up some white things that look kind of like long marshmallows. They call them capacitors. And it develops more current. It's like storing water in big water balloons. And then the balloons break. But these balloons re-form themselves every time they break, so they break and then they re-form themselves. So they fill up -- zzzooooop -- and then they go kapow! So the electricity from those guys goes into some tubing here at the top. And this tubing goes bang, bang, bang, and it hits this thing. It looks kind of like a reddish-brownish thing, but what it is, is two thousand turns of real fine wire. And the real fine wire isn't connected to anything other than this at the top. And it's not connected to anything at the bottom. It's just sitting there. But when this guy goes bang, bang, bang, bang, bang, it makes about 400,000 volts in this. And the voltage jumps off at the top. That thing's called a Tesla coil.

Also, we have chemicals that we're going to use today, and later if we have time we might make some sort of a flaming thing. Yeah, we like flaming things. Let's see, but first we need a crazy story.

Story, Part 1:

"Evil Mister Fred's Wicked Circus, Part 1"

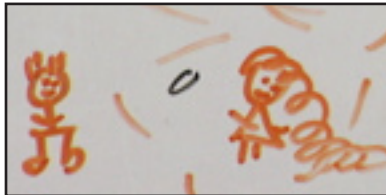
[01:02:54;22] Okay, let's suppose Jack and Jill are working for the circus. And if you're going to work for a circus, you have to have a tent. And the tent is held up with big poles, like that. Usually a pole comes up a little ways, with a flag on the outside. We're going to draw what's inside the tent. Have you ever been to a circus before? Now, there's a place there for people to sit. So all the people sit in bleachers around the edges. So here's people. And then down



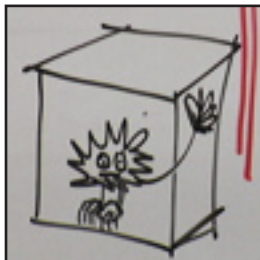
The Circus Tent with two poles.



Evil Mister Fred is Ringmaster.



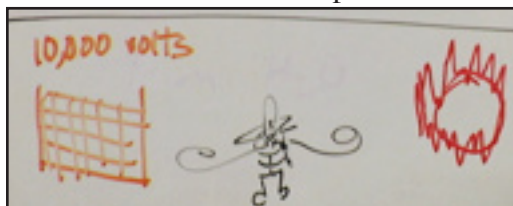
Jack & Jill with Jill's bad hair.



Lion in Cage.



Cannon



10,000-volt Fence & Ring of Fire.

here they have the Master of Ceremonies, who wears a tuxedo. And he tells everybody what's going to be happening that day. He's got a microphone, and he says, "Welcome, ladies and gentlemen, to the big top. Today we have an exciting program for you. We have lions, tigers, bears, vicious animals of all sorts, pythons, and we're going to be training them to do special stuff." Of course, Evil Mister Fred is going to be training them to do some really special stuff.

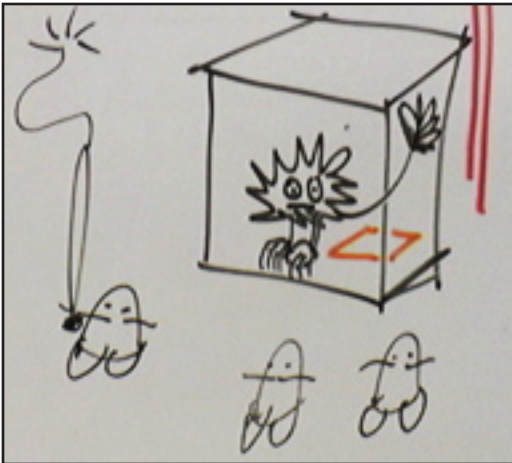
And Jack and Jill are in the audience. Here's Jack. Here's Jill. And Jill's having a bad hair day. Her hair is going everywhere. And people are getting really annoyed because her hair's getting in their way, and it tickles, and it's getting too hot. But there it is -- they just have to deal with it.

And Evil Mister Fred has a cage out here with lions in it. Lions have big manes, a couple of eyes, and he's got a tail with a fluff on the end of it, and claws. And Evil Mister Fred is going to let the lions out, the lions are going to run around in circles, they're going to jump through a hoop of fire -- there's a hoop of fire. They're going to jump over a 10,000-volt fence. So we'll put a 10,000-volt fence here. And they're going to jump into the mouth of a big cannon. And the cannon is going to shoot the lions off of a basketball hoop, and see if you can get two points. Three points if you're beyond the three point line.



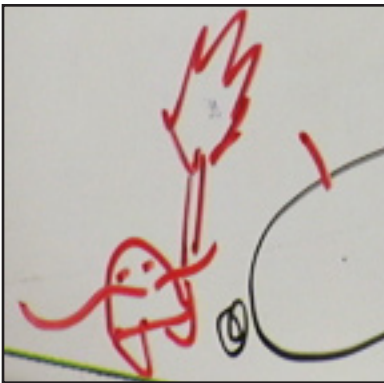
Basketball Hoop.

So Evil Mister Fred opens the cage by blowing on a whistle. The lion tamers come out. They're minions with baseball bats. And one minion had a baseball bat with a whip on the end -- crack! -- like that. And the lions are supposed to go through this whole thing and make everybody go, "Ooh, ahh!" while they're doing it. Buy Evil Mister Fred has connected the lion cage to a trap door. And down below the tent there's a bunch of other animals. All the other vicious animals you can think of: snakes, tigers, bears. Teddy bears? Bananas? Man-eating bananas.



Minion Lion Tamers & Trap Door in Cage

And as soon as he opened the cage door, the lion ran out, ran past the cannon, jumped over the 10,000 volts, ran through the flaming fire stuff, came around the turn, and he was about ready to jump into the cannon. At this point, everybody's eyes are focused on the lion. They're paying no attention at all to the trap door, except for Jack, who's a little weird. The lion leaps up into the air, jumps into the cannon, and at that point all the other vicious animals come running out. Giant spiders, everything's now running out. Yeah, tarantulas. Everything that's big and scary comes out.



Minion at Cannon.

And one of the minions is over here with a flaming torch, and there's a fuse sticking out of the cannon. He's all dressed in red so people notice him. And he's going to light the fuse. And he does. He lights the fuse -- ka-boom! The cannon goes off, the lion flies through the air and goes splat on the backboard, and drools down and makes two points. Three points because he's beyond the three point line.

Well, at that point, now there's animals everywhere, and the people notice the other animals. They're upon them. And Evil Mister Fred says "Ah, ha, ha! They're trapped!" Because he sewed all the doors closed. And the animals are attacking the audience, and it's perfect. Evil Mister Fred likes this. Everyone is screaming, they're trying to get out, the animals are attacking them, and Jack and Jill are there. If you were Jack and Jill, what would you do?



Lion runs around, ends up in Hoop.

Imagination and Brainstorming Time, Part 1

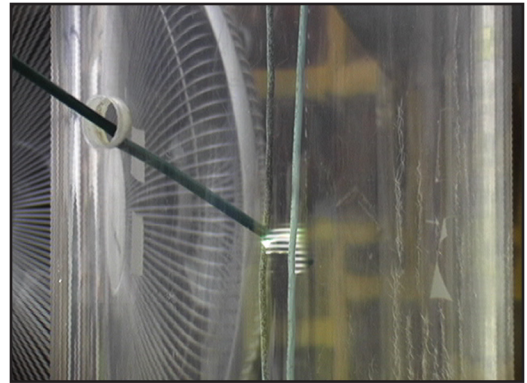
[01:09:43;06] *[Students make suggestions]* (THERE ARE NO WRONG ANSWERS! Whatever they say, you should reply: "That's a good idea," "They might do that," etc. After brainstorming, proceed with the Demos, then continue the story.)

We'll leave this To Be Continued . . .

Demo 1:

Jacob's Ladder, Part 1

[01:13:07;16] Okay, let's turn this guy on first *[turns on Jacob's ladder]*. Switch off the lights. It's really close together at the bottom and far apart at the top. The arc starts down there, but the arc is like, oh, fifteen thousand volts, that turn into thirty thousand degrees fahrenheit. So the air gets so hot that the air wants to go up. As the air goes up, it takes the spark with it until the gap gets too big.

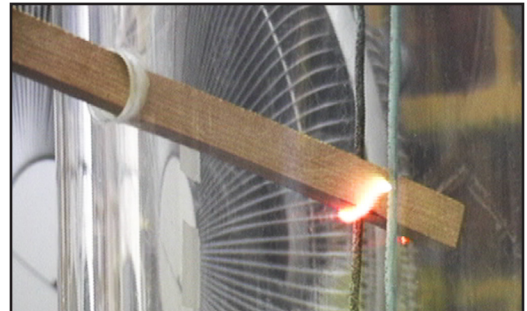


Bamboo Stick inserted between Wires.

Now, we can put things in the chamber. *[Lights on.]* We have a piece of plastic like pvc, a piece of plastic that's clear, and a stick, and a piece of bamboo. The electricity that goes through the power lines around the city, in many cases it's about this high in voltage. You don't want to climb those poles.

But we're going to put this bamboo stick in there *[inserts bamboo stick through small hole in chamber]* and let the spark go right by it. Even though the spark is really hot, the stick doesn't get burned. If we can find the spot where we can make the spark stay, sometimes we can trap it. We're going to trap it later with a different gas, but you can see that it just doesn't go through the stick. The stick doesn't conduct at all. Let's see if we can put the stick someplace where the spark might come up and hold it for a little bit. If you can get the stick to burn on the end, the charcoal will conduct, and sometimes you can get it to stay there. *[Withdraws bamboo stick.]* Look at that. Not even burned.

Let's try a regular stick. A fatter stick might block it off. *[Inserts wooden stick.]* I'll put it down a little lower. Let's let it go by a few times. If we can get some carbon to burn on there, it might stay there. There we go *[bottom edge of stick starts to blacken]*. Now, they always tell you that if a power line falls near your house, run away. But if there's some emergency and you have to move a high voltage line, if you grab a wet tree branch and try to move it, you'll die. If you grab a really dry piece of wood, you can push a high voltage wire away and not die. But we only want to do that in an extreme emergency. *[Withdraws stick.]* Well, it sat there for awhile, and you can see it got crispy a little bit, just a little bit of brown stuff.



The Wooden Stick starts to blacken.

Now let's try a white plastic piece in there and see what colors you get from there *[inserts white plastic stick]*. The bottom of it is getting too hot *[wires at bottom of gap appear to start burning, so the instructor jiggles the wires a bit and it stops]*. It's about the same color as the others, a kind of orangeish color. *[Withdraws stick.]* And that one is okay. Now this has a nice little groove in it so we can put a piece of paper in there. What would happen to paper? *[Inserts a small piece of paper in the groove in the plastic stick.]* We'd like it so the paper



Paper burning on the Plastic Stick

doesn't fall off. I know -- we can make it like a flag. There, we've got a flag. And we'll put paper in there -- I've got to make it so I can get it back out again, because it'll probably catch on fire. *[Inserts white plastic stick with paper attached to the end and rotates the stick so the paper faces downward. The paper begins to burn almost immediately.]* Aw, paper actually burns up. Yeah, and there's smoke in there. *[Withdraws stick.]* It's hot enough to burn paper, but not enough to burn plastic. Here comes the fire department. *[Assistant brings a spray bottle of water and extinguishes the burning paper.]* That's good. Now the end of this is all burned up. We'll take our paper piece out. Crispy critter. Now it's all wet.

[Reinserts stick, which begins to burn.] Ohh, now that it's been burned already, the carbon lets it hold the spark, and it can just sit there and burn, burn, burn. Can you see how bright that is? Yeah, you've got blue on one side and white on the other. Can you turn off the lights? Maybe that will be better. *[Lights off.]* There you go. Okay, you can put the lights back on.

Now we have a helium tank here for helium balloons. I'm going to put this cork back in *[plugs the hole in the chamber where the sticks had been inserted]*. There's a vacuum pump that should be sucking the smoke out and putting it outside. I don't want to blow it into the room, though. We're going to wait before we do the helium, because if I force helium into there, the smelly smoke will get into the room. So we're going to let that vent itself out a little bit.

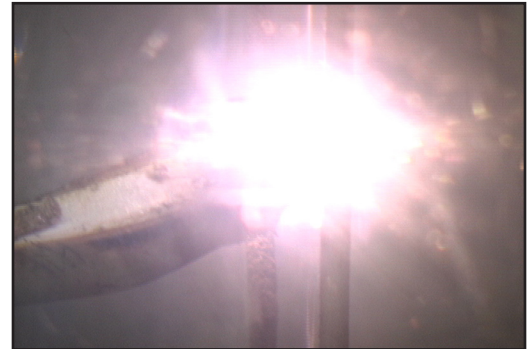
While that's doing its thing, I'm going to turn that off while it's venting itself. That's a quick demo. We'll figure out an ending for our story, and then I'll show you what happens when we put helium inside of that.

Story, Part 2:

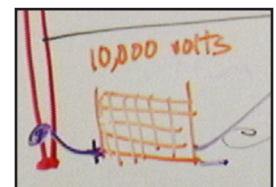
"Evil Mister Fred's Wicked Circus, Part 2"

[01:23:09;03] So Jack and Jill are there, wild animals are everywhere, people are screaming, yelling all around, and Evil Mister Fred thinks this is great. All the animals are trained so they attack people. And then Jill says, "We've got to do something fast." She said, "Jack! Go by the ten thousand volt thing and put your feet on the pole." And Jack says, "No, I'll die!" And Jill says, "Okay, what do you want to do then? We need some high voltage, fast!" And Jack says, "Well, you're having a bad hair day anyway. Let's just connect your hair to the poles." And Jill says, "Okay."

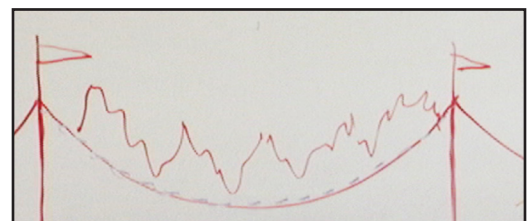
So they put the positive side to this pole, and the negative side to that pole, and the ten thousand volts went between these two poles. And along the tent there it started to create arcs and sparks, like that. And it burnt the tent a little bit, like it did that



Now that the Plastic Stick has been charred, it burns very brightly.



Jill's Hair between Fence & Poles

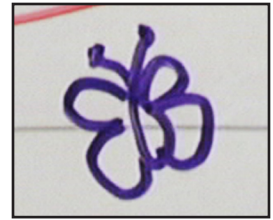


The Tent catches Fire.

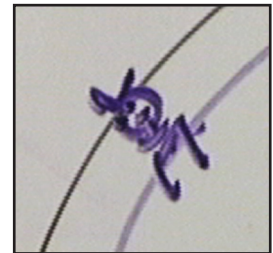
stick. And it's going zappity, zappity, zappity, zappity, zap. And flames are coming out of the tent. And Jack said, "Okay, that's good, now we have fire, wild animals, and the Evil Mister Fred all in one spot." Lets put some flames up there. And Jill said, "Well, I guess we better just wait and see what happens." When the tent got all carbonized, it was like lightning bolts going pssshk! pssshk! pssshk! from pole to pole.

And the animals hate fire, and they're going "Aaaaahh!" Now they're panicking. They're running all over the place, they're ignoring the people at least, trying to find some way out. And Evil Mister Fred is afraid of fire, too. And Evil Mister Fred also happens to be deathly afraid of butterflies. And when the tent burned open, one little tiny butterfly flew in through the burning opening. Evil Mister Fred saw it, and screamed at the top of his lungs, "Aaaaaahhh!" And he ran right through the wall on the bleachers and left an Evil Mister Fred-shaped hole. And the animals followed Evil Mister Fred out.

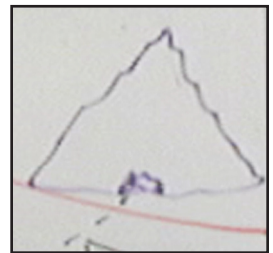
And now there was just people left in a burning tent. And Jack and Jill said, "Oh boy, this is bad. We've got to get you guys out of here safely." And Jack said, "Why don't we just blow the tent up? It's already on fire." And Jill said, "No, I don't think so. Let's go down through the trap door." So everybody, quick as they could, went down through Evil Mister Fred's trap door. And they discovered underneath all the cages where the animals were supposed to be, a secret tunnel that led out to a mountain way off in the distance. And everybody was able to escape safely. The tent burned down completely. The animals were still alive and were running around through the city. And we have to leave it to be continued again because we have another thing we're going to be telling you about.



A Butterfly flew in.



Evil Mister Fred crashed through the wall.



The Mountain.

Demo 2:



Jacob's Ladder, Part 2

[01:26:52;22] [Turns on Jacob's ladder.] Now we're going to put some helium in there. Is helium lighter than air or heavier than air? Yeah, it's lighter than air. What color is the spark right now? Let's turn off the lights so they can see the spark. [Students: White. Yellow.] White, yellow? Doesn't look any greenish to you guys? [Students: A little bit. Barely.]

Well, now we'll put some helium in. [After a few seconds, spark stops rising.] If it get's too hot at the bottom, sometimes the spark gets stuck. [Spark starts rising again.] [Students: Purple.] It's supposed to be purple now. Okay, switch the lights back on. Well, that is our Jacob's Ladder.

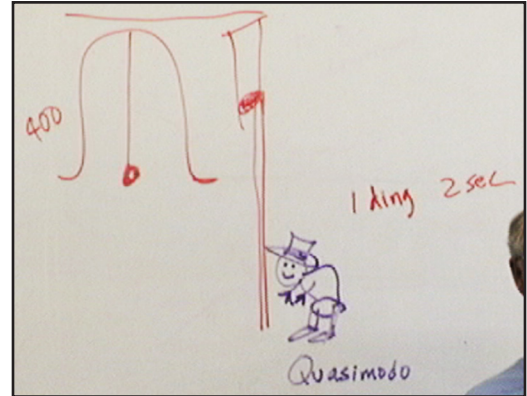
Adding Helium to the Chamber.

Demo 3:

Tesla Coil, Part 1

[01:29:22;29] Now, we want to use the Tesla coil. Tesla coil does a little bit more than the Jacob's Ladder. *[Erases whiteboard.]* I need to erase this part. Remember, there's wild animals in a big city. And Jack and Jill and all the people in the city are stuck in a mountain.

Have you heard of the cathedral of Notre Dame? What's the name of the guy that was in there? Quasimodo, yeah. Quasimodo was a little guy with a hunchback. Was he deaf? I bet he was. He looked like . . . what was the little guy in the Lord of the Rings? Looks like Gollum, yeah. And he wandered around. Did he have a hat? This guy does. There -- little hunchback guy, Quasimodo. Is it a cute Quasimodo?



Quasimodo rings the Bell.

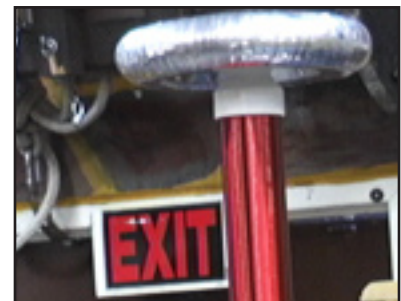
And Quasimodo's job was to go around through the cathedral and scare everybody. And his job was also to ring the bell. There was a bunch of bells there, and there were ropes attached to them. And the ropes attached to a big bar and hung down. And there was a bell there with a dinger in it. And if you make the whole bell rock, the dinger's just hanging straight down. And it would hit the walls and the bell would start to ring.

Well, imagine a Quasimodo that could ring these giant bells, and those bells might weigh a ton or two. And he could pull on the rope, and the bell might take a couple of seconds to go dingggggg, dingggggg, dingggggg. That's about as fast as he could ding them. So he's dinging about maybe one ding every two or three seconds. And the bell, when it vibrates, goes BONGGGG! -- something like that might be like four hundred vibrations per second. So by just one simple ding, he's creating four hundred dings, four hundred vibrations per second.

Well, a Tesla coil works like Quasimodo ringing bells. This bit of copper down here, you see that copper-colored stuff? That stuff dings at 120 times a second. This stuff dings up here *[indicating red wires]* at about a hundred million times a second. So it's really going fast -- brrrrinnngggg! And when it gets up here, it has a really, really high voltage so that it can shoot sparks out.



Coils ding 120 times per sec.



Red Wire dings 100 million times per sec.

Story, Part 3:

"Evil Mister Fred's Wicked Circus, Part 3"

[01:32:55;05] Now, we want to continue our story and add that to it. So, let's suppose Jack and Jill are inside this mountain with all the people trying to find their way out, and they meet some people in the mountain where they're hiding. And when the people realize that Evil Mister Fred is not there, and all his creatures were not there, the people came out to talk to Jack and Jill. Let's put Jack and Jill here. What should they be standing on? How about a giant banana? A giant vicious banana, with vampire teeth. [*Student: Is it a monster?*] It could be. You never know what Evil Mister Fred's going to leave behind.

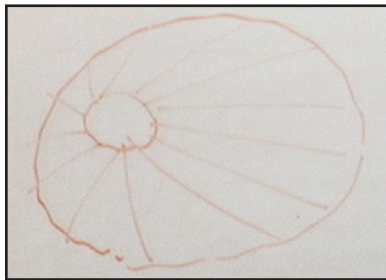


Jack & Jill on a vicious vampire banana.



Weird Guy with bump on forehead.

And the people came out, and the people had two eyes like regular folks, they had a head like regular folks, they had bodies like regular folks. They had long wispy hair. But their eyes were closed. They never opened their eyes. And they had a bump in the middle of their forehead, like that. And Jack and Jill walked up to one of these people and said, "Hey, you guys live here inside the mountain?" The guy says, "Yeah." Jack said, "But your eyes are not open. How can you see?" The guy said, "Well, we don't need to see. It's always dark in the caves in here, so we have these bumps on our head. And the bumps send out energy waves, and we can detect anybody or anything that comes into our caves." And Jack and Jill said, "Wow! That's great! Then, how many caves do you have in here?" They said, "Oh, there's hundreds and hundreds of miles of caves inside the mountain." And Jack and Jill said, "All right! But you don't look very strong. How did you make all those caves?" He says, "Well, we figured out a way to make caves without using picks and shovels. That's old fashioned. We make caves by using sound waves." And Jack and Jill said, "What?" He said, "Yeah, I'll show you."



The Weird Guy's Tunnel.

And he walked over to a wall, and he just stood there and looked at the wall. And Jack and Jill heard this really loud, low, vibrating noise -- bong, bong, bong, bong, bong. And the wall started to chip off, and pieces of rock were falling on the ground. And then as the energy got higher and higher, the rocks started to melt. And as it melted, it formed a tube that went on like this. And somehow he was making sound waves that would vibrate the rock so much that it would melt and form thick walls of molten rock and shrunk it down to create these caves. Jack said, "Wow! That's great! What would happen if you pointed that at, oh, say, Jill?" And the guy says, "We don't do that. Jill would go pffttt!" And Jack ran over, and the wall was glowing orange. Jack said, "Can I touch it?" The guy says, "Yeah, go ahead." And Jack touched it and it was just warm. It wasn't really hot. And Jack and Jill ran into there, and they could see the end of it. And they said, "Show us more." And he said, "Oh, we have lots of people living here in this mountain. We've been here for thousands and thousands of years. Nobody seems to bother us, and we don't bother them, so we're left alone." And they said, "Well, how did Evil Mister Fred get in here?" And he said, "Oh, that Evil Mister Fred! He's a rotten one. You know, we made a promise we wouldn't kill people, but boy, he

tested us to the very end. Evil Mister Fred came one day, and he blew a big hole in the side of the mountain with dynamite. And he brought in all his animals and trained them to kill people. Boy, oh boy, is that guy rotten! And we didn't do anything. We just let him do his thing." And Jack and Jill said, "Well, we have a problem now. There's a city out there, and Evil Mister Fred has taken all his animals and he's letting them run wild in the city. If we go back home, we're going to get eaten up." And the guy said, "Well, that's bad. You don't want to get eaten up." Now if you were Jack and Jill and you had a guy like this, what would you do?



Evil Mister Fred blew a hole in the side of the mountain.

Imagination and Brainstorming Time, Part 1

[01:37:34;10] *[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 demo and experiment, then finish the story.)

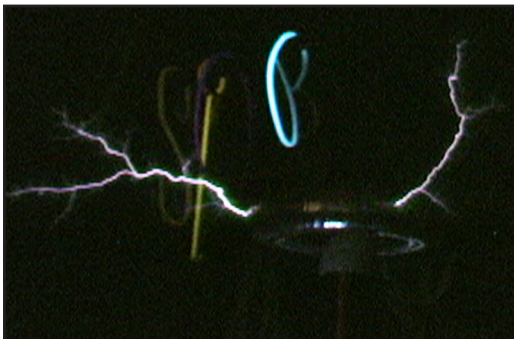
We'll leave this To Be Continued . . .

Demo 4:

Tesla Coil, Part 2

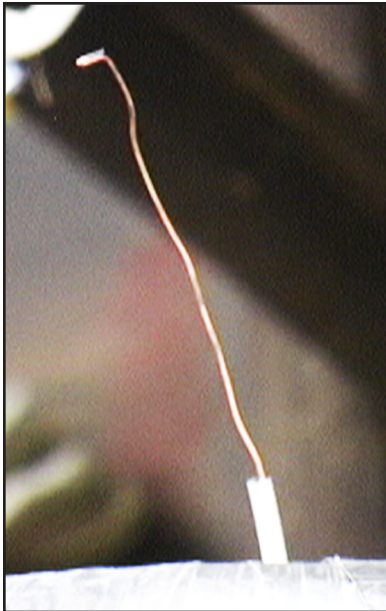
[01:41:13;21] Now, we're going to turn this on so you can see what it sounds like. We're going to turn it on for a second, but the objective of using this is to make monsters. And there are various kinds of monsters you can make with it. You can make monsters that look like that *[large plastic tape reel]*. It has a cup on the back so it doesn't tip over. This was a monster somebody brought in at Halloween *[plastic pumpkin]*. And this is a monster we made out of a bottle *[2-liter plastic bottle]*. But the monsters aren't very scary the way they are. We want them to be scarier monsters. And they'd be scarier if sparks shot out of their eyes. So we're going to try to make them so sparks shoot out of their eyes. And you're going to create your own, but first we'll do a few things with that so you can see what it's like. If you're not comfortable with sparks shooting all over the place, you might want to move a little bit back. So let's take this first row and move them back where they're more comfortable.

[Indicates top of Tesla coil.] There's tiny little sparks jumping out of here. And you might hear a loud banging sound from these tubes because they kind of ring like a bell. So you can plug your ears if you like. I'd like you to hear it for at least a few seconds the way it really sounds, and then when we're doing the experiment you'll all have earmuffs on, because you don't want to have the sound loud for a long time.



Sparks coming out from the Tesla Coil.

We're going to turn on the leaf blower. *[Turns on leaf blower that's attached to Tesla coil, turns off lights, and turns on Tesla coil, which produces sparks at the top.]* That's the sparky-sparky thing. A guy named Nicola Tesla invented that. He was a very strange guy. If we have time, I'll tell you later some of the weird things he did.



Copper wire "horn"

If at the side, we're shooting out horns like maybe a deer or something, we're going to put one horn on the top [sets a copper wire on top, pointing up]. Oh, yeah, you can put your earmuffs on now.

[Demonstrates various objects placed on top of the Tesla coil: the copper wire, the plastic pumpkin with aluminum foil attached to it, to show how the sparks jump.]



Plastic Pumpkin with Aluminum Tape making sparks.



Experiment

Experiment: Make a Monster that Shoots Sparks

[01:44:52;23] So you're going to have choices about how you're going to make your monster. Here's aluminum tape. It's got a backing on it, so it doesn't stick, it's not sticky there. You can cut it with scissors and get it the shape you like it first. When you have the shape that you like, then you have to peel off the tape backing stuff. If you've got fingernails you can do it. There it goes. When you get it off, then you can stick it to whatever you're going to use it on. You have a choice of using a bottle shape to start with, because it stands up by itself; a big circle shape that can be glued to a cup so that it will stand up; or a disk that we'll put on top of a cup. When you stick your tape on and whatever monster fea-



Peel-off Aluminum Tape

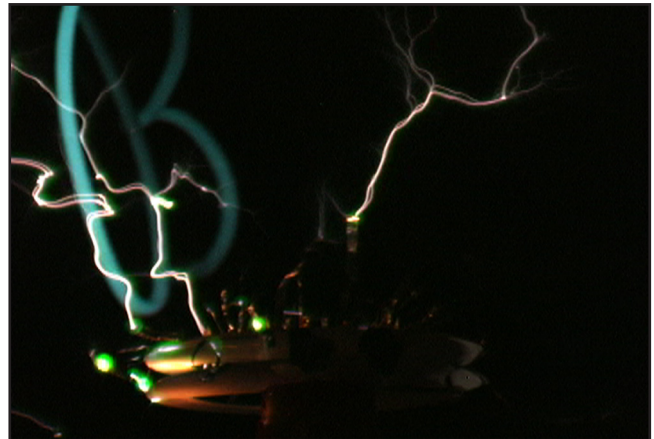
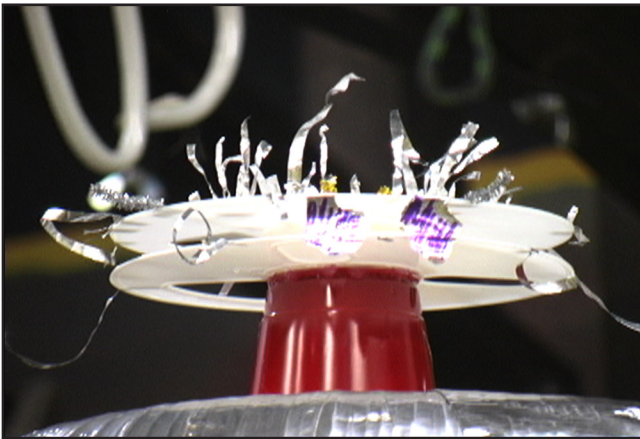


Three possible shapes for Monsters: large tape reel, small tape reel, or 2-liter plastic bottle.



tures you want to add to it, we also will give you pipecleaners that will conduct electricity. So the idea is to make something as scary as possible, so that when we turn on the electricity, sparks shoot out all over the place, and everybody in the room goes “Aaaaaahhhhh!!!” and runs and hides. If yours catches on fire, you get extra points. *[Student: Do you get to make a new one?]* No. Are there any questions before you start? Usually we only have time to test them once. We'll just see how time goes. So you decide whether you want a bottle, a big circle, or a little circle.

[Students choose their shapes and decorate them. When they're all finished, they put on earmuffs. Then the Instructor places each monster on top of the Tesla coil, turns on the power, and turns out the lights so students can see the sparks jump out of their monsters. Some catch fire briefly.]



A small-disk Monster on top of the Tesla coil, before and after the electricity is turned on.

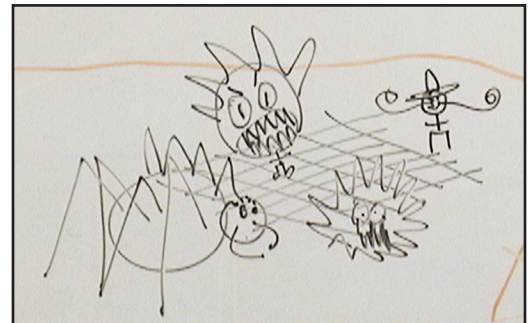
Story Ending

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

[02:08:45;18] So Evil Mister Fred has taken over the town with all his wild animals. He said, “They may have burned down my tent, but I’ll show them. When they come home, boy, will they be surprised. They’ll walk through their houses and they’ll be eaten up by my wild animals.”

And Jack and Jill were over in the mountain talking to the weird guy with the bump in the middle of his head. And they said, “What are we going to do? That Evil Mister Fred’s out there. We’ve got to do something.” The guy says, “Well, you could make a tunnel under the ground to your town. That’s pretty easy.” Jack and Jill said, “Well, okay. And what do we do with the tunnel?” He said, “Well, that’s up to you.” So he started working on the tunnel.

And Jack and Jill said, “Okay, we’ve got to find some way to scare all those creatures away.” And Jack said, “All right, let’s take a really big battery, wrap wire around Jill, and turn on the electricity. And then maybe her hair will do something cool.” So he did. Put his big old battery on there, lots of wire wrapped around her,

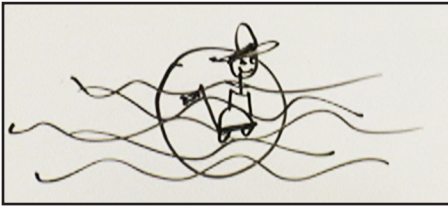


Evil Mister Fred's Wild Animals in the Town.



Jill wrapped in wire.

turned on the power, and Jill's eyes lit up and sparks shot out of her hair. And she lifted up her hands, and sparks went wzzzzzzhh! all over the room. And Jack said, "Yeah! I like that."



Evil Mister Fred on his vacuum cleaner.

So they waited until it was a dark cloudy night. There was a mist across the moon. And Evil Mister Fred was flying on his vacuum cleaner. That's because he's chicken, and he wouldn't wait in town with all those monstrous animals. Jill and Jack came through the tunnel, they opened up the hole, and they looked around and the streets were empty. There were creatures hiding in all the houses.

And Jill came out, and she says, "Yeah, I'm here. I'm in town. You guys can't get me. You guys in the houses, you're all chicken. Yellow-bellied animals. Afraid to come out and fight with a little girl."

And the animals were inside going, "Oh, yeah? She can't say that about us. Did she say that about you? She can't say that about me. I'm gonna go get that kid." Those animals all ran out. "Aaaarrrrrgggggh-hhh!!" And Jack turned on the power. And Jill went Bzzzzzzzztttt!! Sparks jumped all over the place, the animals flew up into the air, flaming, mad, angry -- "Rrrrrraaaaahhhh!!" They couldn't go down where Jill was because they were afraid of Jill, so they attacked the only thing they could find. And that was Evil Mister Fred. And they all lived happily ever after, except Evil Mister Fred. *[Students: And the animals!]* I don't know. What happened to the animals? Maybe they went down into the tunnels. They could go live with the guy with the funny bump on his head.

End of Lesson