



## Teacher's Guide for: **Color Changers**

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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#### **Title Page of Video**

Color Changers  
A Rock-it Science Lesson  
Filmed July, 2009

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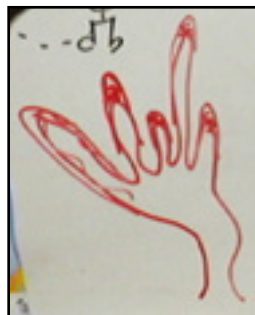
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## Demo Quick Recap: "Acids and Bases"

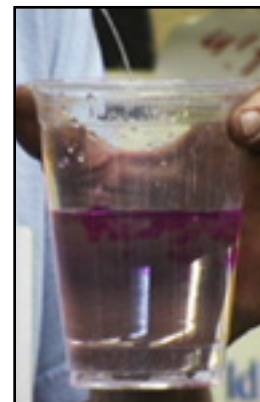
- Do you know the difference between an acid and a base?
- Do you drink acids? What kind do you drink?
- A base is something like soap. We don't eat soap.
- Magicians use chemicals in their acts, and we'll use some in our experiments.

### Demo # 1: "Magician's Trick with Phenolphthaleine"

- One of the oldest magician's tricks is to take something that looks like plain water and make it change colors magically.
- Take a glass of water and add a clear liquid (phenolphthaleine) to it, then stir it with your finger.
- Magicians have fake rubber finger tips in which they can hide things, including chemicals. When they stir a liquid with their finger, they're really adding a chemical to the liquid.
- Add a second chemical (ammonia) to the glass of water and stir it with your finger, turning it purple.
- Add another chemical to the water (distilled vinegar) to change it back to clear.
- Then add the second chemical again (ammonia) to make it purple again.



Magician's  
Fake Fingers



Ammonia added to  
phenolphthalein  
solution turns  
water purple.

### Demo # 2: "Magician's Trick with Cabbage Juice"

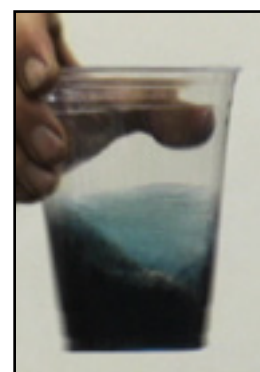
- Pour a small amount of red cabbage juice into three clear plastic cups and pour it back and forth so students can see that it's blue.
- Pour some ammonia into first cup of cabbage juice so it turns green.
- Pour some vinegar into the second cup so it turns reddish-purple.
- Ask students what will happen if you combine the green and the reddish liquids. Combine them so it turns turquoise.



Red, Blue, and Green  
Cabbage Juice



Pouring Green into Red (right)  
makes Turquoise (far right)



### Demo # 3: "Making Fizzy Water"

- Instructor takes a clear plastic cup containing about 1/2 cup of baking soda solution, and a second clear cup containing about 1/2 cup of distilled vinegar.
- Ask students what would happen if you held one cup over someone's head like a magician and poured the other one in?
- Pour some of the vinegar into the baking soda solution and wait for it to stop fizzing so it doesn't overflow. If there's enough room, pour in the rest.
- You've created fizzy water, which shows that you can get a reaction from these two liquids.



Vinegar added to baking soda solution makes fizz.

### Demo # 4: "Reveal Invisible Writing"

- Prior to this demo, and out of sight of the students, the Instructor writes a message in vinegar on a half-sheet of goldenrod paper.
- Instructor has a large clear plastic tub with a small amount of ammonia in the bottom and a piece of cardboard covering it to keep the fumes from escaping.
- He holds the goldenrod paper inside the tub, but without touching the liquid ammonia.
- The paper turns orange and the message appears in red.



Ammonia fumes reveal invisible message written in vinegar.

## Experiment Quick Recap:

### Experiment # 1: "Drawing with Color Changers"

- Pass out a sheet of Wasau AstroBright goldenrod paper to each student, along with a Q-tip for a "paintbrush" and a 2-oz. plastic souffle cup containing the baking soda and water solution (don't tell students what's in the cup).
- Tell students to draw whatever they want. Tell them to save some space for other chemicals. (Paper turns red where the liquid touches it.)
- After a few minutes, pass out a second souffle cup containing vinegar, but don't tell students what it is. Let them draw with it, using the other end of the Q-tip. (The vinegar erases the lines they drew with the baking soda.)
- After a few minutes, Instructor walks around with a spray bottle containing ammonia and sprays a fine mist on a section of each student's paper without telling them what the chemical is. Depending on how much vinegar was applied, the ammonia will make the image reappear.



Drawing with Baking Soda solution.

### Experiment # 2: "Invisible Writing"

- Instructor passes a sheet of thin white cardboard to each student, along with a new Q-tip and another souffle cup containing another unknown clear liquid (phenolphthalein solution).
- Students draw with the new liquid, and the image is invisible.
- Students bring drawings outside to let them dry completely in the sun.
- Instructor sprays the image with ammonia, making the image turn purple.
- Students then hold their pictures in the sun so they dry out and become invisible again. If time allows, Instructor sprays them a second time so they reappear.



Ammonia spray reveals invisible image.

## Equipment List: "Color Changers"

### Items needed for Instructor:

- Baking Soda, 1/2 cup (see Prep work)
- Cabbage, Red, large (see Prep work)
- Phenolphthalein powder, 1 tsp. (see Prep work)
- Alcohol, rubbing, 16 oz. (see Prep work)
- Ammonia, household, approx. 8 oz.
- Vinegar, Distilled, approx. 1 qt.
- Water, 1 qt
- Bottles, plastic (approx. 1 qt.), for baking soda & phenolphthalein solutions (2)
- Bottle, plastic (approx. 1 qt.) with spray head for ammonia
- Jug, plastic (approx. 1 gal.), for cabbage juice
- Cups, Clear Plastic, 12-oz (6 ea.)
- Pipettes (2)
- Wooden Trays to hold souffle cups (from Disease Spreading box)
- Tub, clear acrylic, about 1 cu. ft.

### Items needed for Students:

#### Consumables:

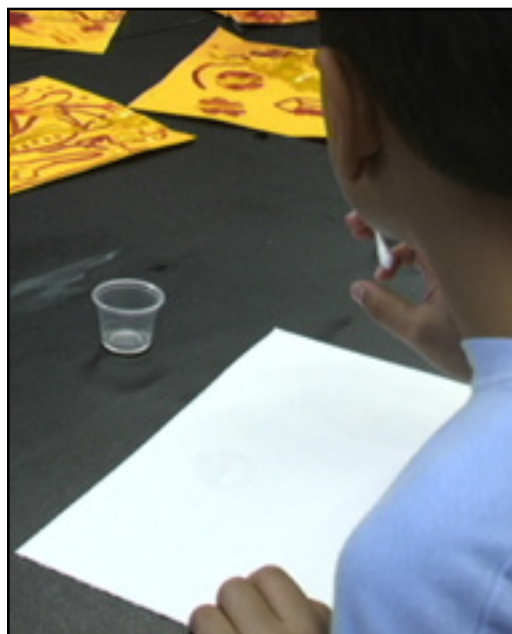
- Paper, Wasau AstroBrite Goldenrod, 1 sheet. (This is the ONLY brand that works for this experiment. However, it is no longer being manufactured. You may still be able to find it on the internet, but it's expensive. An alternative is to make your own goldenrod paper using turmeric, an Indian spice.)
- Q-tips (2 ea.)
- Cups, Clear Plastic, 2-oz. Souffle (3 ea.)
- Baking Soda solution (about 1 oz.)
- Vinegar, Distilled (about 1 oz.)
- Cardboard, thin white, or sheet of white index stock
- Phenolphthalein solution (about 1 oz.)

#### Other:

- (None)

### Prep Work:

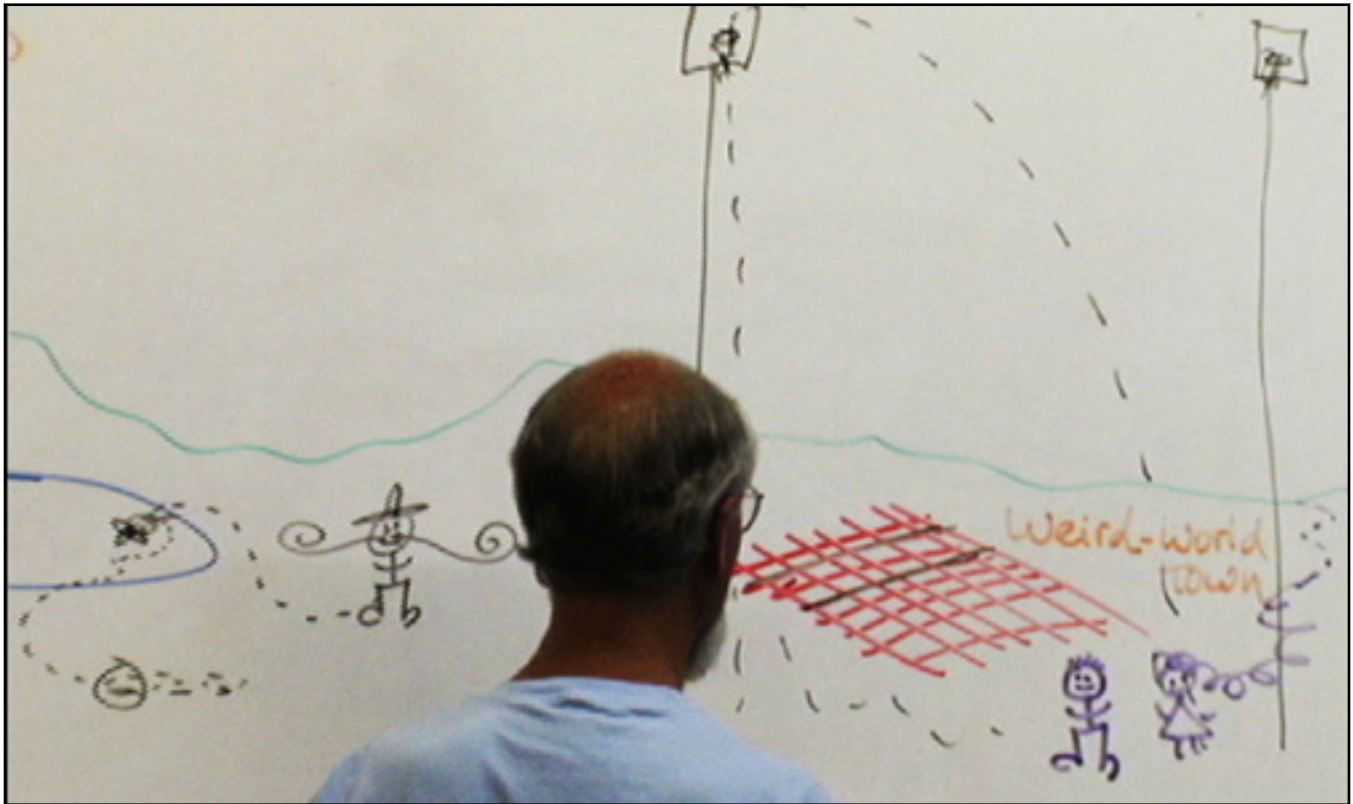
- Mix Baking Soda solution: 1/2 cup of baking soda dissolved in 1 qt. water so it's saturated. Excess baking soda will settle at bottom of container.
- Mix Phenolphthalein solution: 1 tsp phenolphthalein powder dissolved in 16 oz of rubbing alcohol.
- Prepare Red Cabbage Juice: Chop up 1 large red cabbage, put it in a big pot, and add 1 gal. of water. Bring it to a boil and then turn off heat. Let it cool and strain off the juice. Pour into a plastic jug and keep refrigerated.
- If necessary, make your own goldenrod paper using turmeric (an Indian spice) and alcohol. For instructions, search online for "How to Make Goldenrod Paper."



Goldenrod paper & white index.



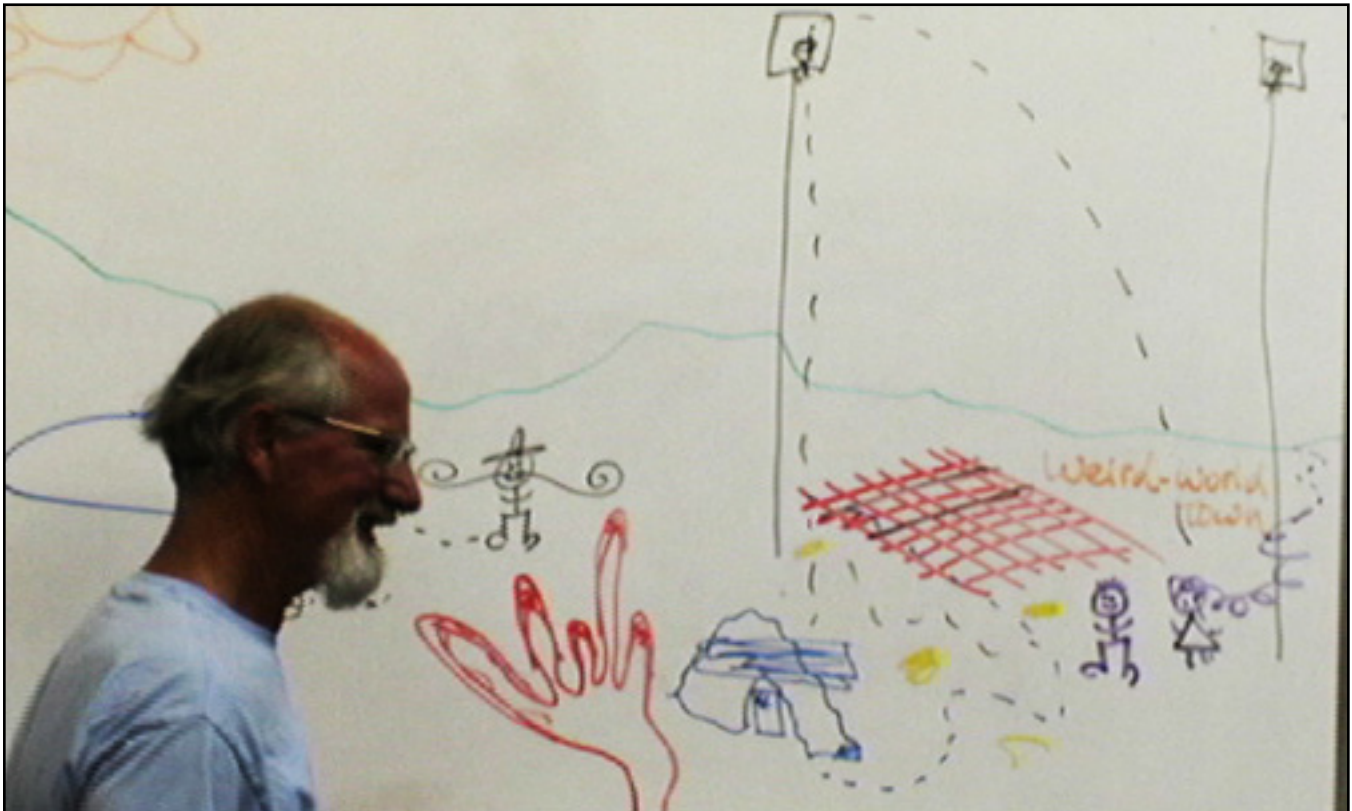
## Story Recap: "Evil Mister Fred in Mirrorland"



### Part 1:

- Evil Mister Fred was admiring himself in a mirror when the mirror yanked him inside.
- Now there were two Evil Mister Freds inside the mirror, and they started fighting.
- The one in the mirror ran away, and the real one couldn't get back out.
- He wandered around and discovered that everything there was good. Roses without thorns, cats that don't hiss or scratch, no poison oak in the woods.
- He came to a town where the houses were glowing every color of the rainbow. Jack and Jill lived there, and all the kids played games. A truck ran over some kids, but they just peeled themselves up off the ground and started playing again. The basketball hoops were two hundred feet in the air, and the kids could jump up that high and dunk the ball.
- Evil Mister Fred saw his reflection in a lake and dove in. The other Evil Mister Fred took him to a cave where he could breathe and gave him a squirtgun.
- Evil Mister Fred swam back to the surface and started squirting things. He discovered that it changed the color of whatever he squirted it at, and the colors continued changing.
- People got confused and angry because they were all changing colors and they couldn't tell who their friends were. And they started fighting with each other.

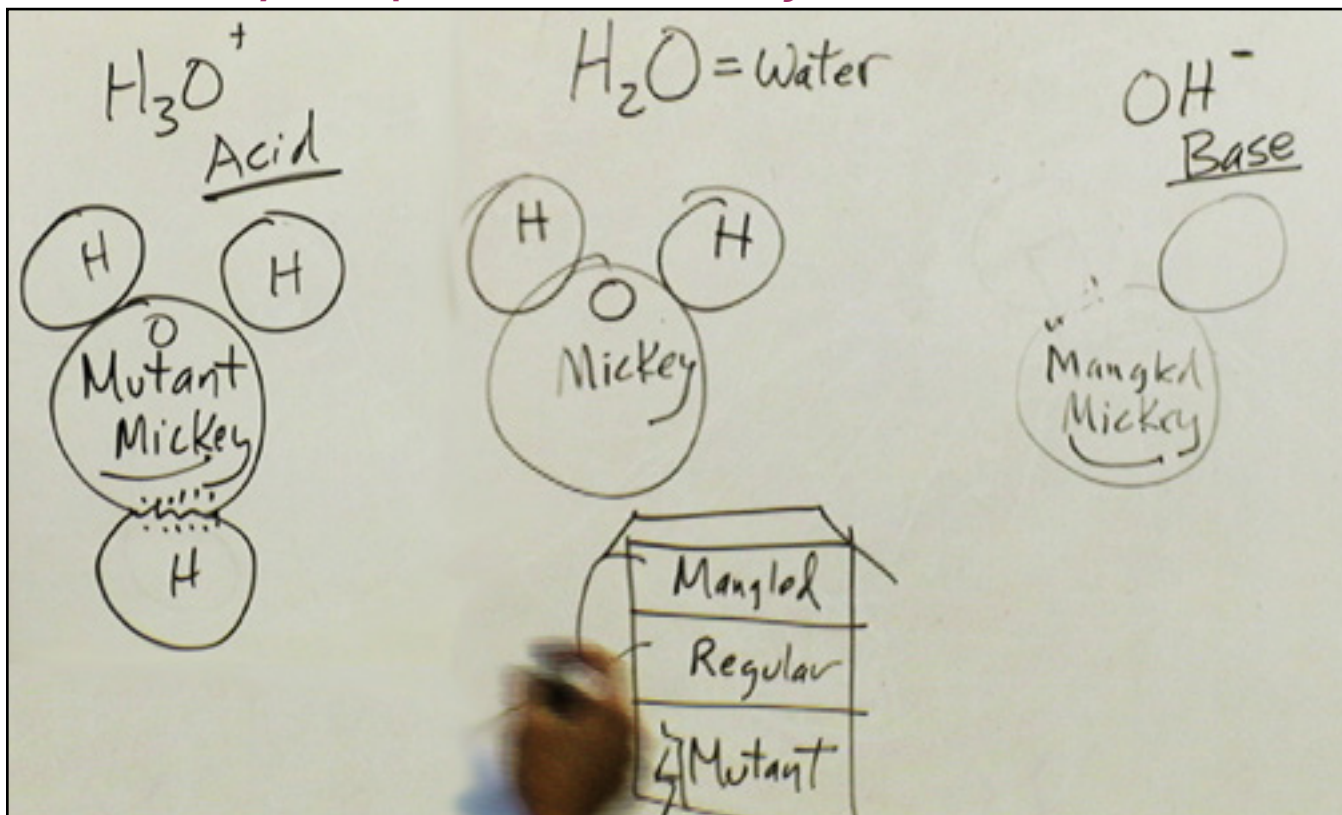
## Story Recap (cont.):



### Ending:

- Jill called the Acme Store of Everything and ordered another squirtgun containing a “chemical color restorer.”
- She started squirting things, but Evil Mister Fred was able to keep changing colors faster than she could restore them.
- Jack made a big cardboard hill with a cave in it. In the back of the cave he put a mirror. On the outside of the cave he put a sign that said, “Evil Mister Fred, don’t squirt me, no matter what!”
- When Evil Mister Fred saw the sign, he ran into the cave with his squirtgun.
- It was all dark inside, and he just squirted all around inside the cave.
- When he squirted the mirror, he got sucked into it and disappeared.
- Jack and Jill returned everyone to their natural colors.

## Interim Story Recap: "The Three Mickeys"



- Mickey Mouse lived in a house with his two brothers.
- One brother was mowing the lawn and fell down, and the lawnmower chopped off one ear. He was called Mangled Mickey.
- The other brother liked to sit and think a lot with his chin resting on his hand, and eventually he grew an extra ear on his chin. He was called Mutant Mickey.
- Mangled Mickey lived on the third floor, Mutant Mickey lived on the first floor, and regular Mickey lived in the middle. Regular Mickey told his brothers never to visit each other.
- One day while regular Mickey was away shooting a movie, Mangled Mickey heard loud noises and screams from the first floor. Thinking his brother was being attacked, he ran down there.
- It turned out it was just the television, but the two Mickeys saw each other and immediately ran to embrace each other. At the last moment, they start fighting viciously, breaking the furniture and wrecking the house in the process.
- When regular Mickey got home, he saw that Mutant Mickey's chin ear had been torn off and Mangled Mickey had duct-taped it onto his head where his missing ear used to be.
- Regular Mickey took it back and sewed it onto Mutant Mickey's chin again.
- The Mickeys have the letter H on their ears and the letter O on their heads.
- Regular Mickey is  $\text{H}_2\text{O}$  (water); Mutant Mickey is  $\text{H}_3\text{O}^+$  (an acid, like vinegar), and Mangled Mickey is  $\text{OH}^-$  (a base, like ammonia). When you mix an acid with a base, things happen!



## Transcript: Intro

Do you guys know the difference between an acid and a base? There's first base, second base, and third base in baseball. *[Student: And home plate!]* And home plate, yeah. And do you guys drink acids? What kind do you drink? *[Student: Water.]* Water acid? What else? *[Student: Juice acid.]* Juice acid, yeah. Juice is usually citric acid. *[Student: Milk acid.]* Yeah, there's lactic acid in milk. *[Student: Vinegar.]* Yeah, vinegar's a good acid example.

A base is something like soap. You don't usually eat soap. It doesn't taste good. And there's a strong acid that they put on your teeth when they're drilling your teeth to put in a filling. They put phosphoric acid in there to clean the tooth really good before they put in the filling. *[Student: Baking soda is a base.]* Oh, that's good. Baking soda is a base.

Magicians use all kinds of chemicals in their acts, and we're going to use some chemicals today and see what we can find out about them. But first, we need a crazy story.

## Story: "Evil Mister Fred in Mirrorland"

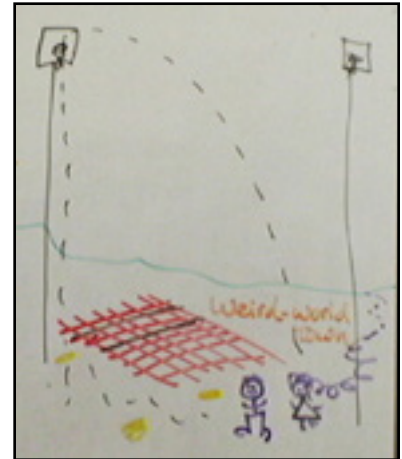
Let's suppose that Evil Mister Fred had gone into a mirror. It was a mirror like that one. Evil Mister Fred was walking in front of it and he noticed himself, and he said, "Oh, boy, am I handsome or what? Yeah, that's me. I'm the man." And he was getting closer and closer to the mirror, and the mirror didn't like him talking like that. And the mirror grabbed him by his ears and yanked him inside. So now there were two Evil Mister Freds in the mirror. And they began fighting with each other. And the one that was in the mirror ran away screaming and yelling, and the real Evil Mister Fred tried to get back out. But he was stuck inside the mirror. He said, "Whoa, what happened here? How'd I get in here, and how am I going to get out? Oh, well. Maybe it's cool in here."

So he started wandering around in the mirror land, and it was nice and green. And there were lakes there, and trees, and birds singing, the sun was shining, and everything was good. Which drove him crazy. He hates it when everything is good. He wants things to be bad. And he was searching for anything that was bad. He looked for a rose bush, and there were no spikes on the rose bush. And he found a cat, and he petted the cat, and he went "Khaaaackkkk!" And the cat didn't hiss back. And the cat tried to knock him away, and the cat had no claws. And then he went out into the woods, and there was no poison oak. There were no mosquitos. This was just the strangest place he'd ever seen before. He said, "Hey, this is not good." And as he wandered around, he came to a town, and the streets were red, and the houses were glowing green and orange and brown, every color of the rainbow. *[Student: Is it a weird world town?]* It could be a weird world town. We could call it that. Weird World Town.

And Jack and Jill were living there, and they were playing games, running around, having a great old time. *[Student: Jack and Jill? How could they be living in that world?]* Why not? It's a parallel universe. And while they were playing the games, a big old truck came by and went splat, splat, splat, splat, splat, and ran over ten kids. And Evil Mister Fred said, "Now we're talking! Some real evil!" And the kids just peeled themselves up off the ground and they said, "Yeah, that was good." And they started playing games again. And Evil Mister Fred said, "Whoa, this is just not right."

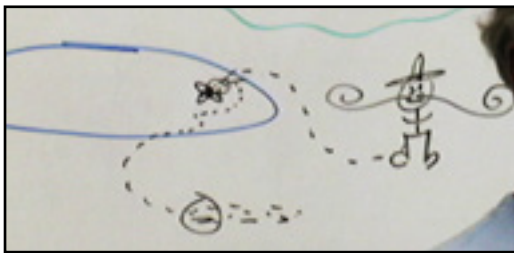
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And the kids were playing basketball, and he noticed that the basketball hoops were a little different from the ones he'd seen. The basketball hoops were two hundred feet up in the air, like that. And Evil Mister Fred said, "Well, what on earth are they doing?" And the kids were bouncing the basketball around like regular folks -- bouncy, bouncy, bouncy, bouncy, bouncy -- and one of them went up to make a shot. And he jumped up into the air, and he flew two hundred feet up in the air and dunked it, and then bounced back onto the ground. [Student: Jack did that?] It could have been Jill. They could all do that. And Evil Mister Fred said, "Oh, man, this is just not good."



Super-high basketball hoops in Weird World Town.

So he went off to sulk and cry and find some way to make these people miserable. So he went off to this lake. And he looked into the lake and he saw his reflection in the lake. And there was an Evil Mister Fred there, looking back at him. And he said, "Hey, I wonder . . ." And so he dove into the lake head first, and here he was, swimming under the water with another Evil Mister Fred



Evil Mister Fred with his reflection in the lake, and a cave down below.

under water. And they went down into a cave, and for some reason he felt he didn't need to breathe. And he was complaining to the other Evil Mister Fred. He said, "You know, things around here are just not right. Everybody's having a good time, too much good stuff going on." And the other Evil Mister Fred said, "Well, yeah, but I could help you out if you want." And Evil Mister Fred said, "Oh, yeah? What have you got? Show me." The guy says, "Well, it's nothing much. It's just a squirtgun." And Evil Mister Fred said, "A squirtgun?

What good is that?" And he said, "I don't know. Maybe you can find some good to do with it." And Evil Mister Fred was really disappointed, but he took the squirtgun and went.

And he climbed back out of the lake and he was walking around. "Stupid squirtgun." And he filled it with water from the lake. He squirted it at a tree, and the tree changed to purple. He said, "Ooh, nice!" He squirted it at a rock, and the rock turned bright yellow. And he said, "I like this. This is fun." So Evil Mister Fred went to town, and he started squirting stuff. And everything changed colors when he squirted it. And then those colors didn't stay the same. They started changing all over the place. And he didn't know who was who, because they kept changing colors.

Now the people started arguing amongst themselves because they didn't know who their friends were, because their friends kept switching colors on them. And now fights broke out, and Evil Mister Fred said, "Love this stuff! This is great! Not only does it change their colors, it makes them fight with each other. Yeah!"

Now, Jack and Jill were there, and they've been watching Evil Mister Fred do this. And they say, "Oh, man, this is bad." If you were Jack and Jill, is there anything you could do to stop the Evil Mister Fred from these shenanigans?

## Imagination and Brainstorming Time

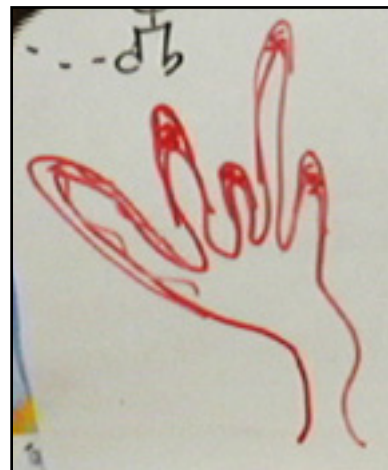
[Students make suggestions] (THERE ARE NO WRONG ANSWERS! Whatever they say, you should reply: "That's a good idea," "They might do that," etc. After brainstorming, proceed with the experiments, then finish the story.)

We'll leave this To Be Continued . . .

## Demo #1: "Magician's Trick with Phenolphthalein"

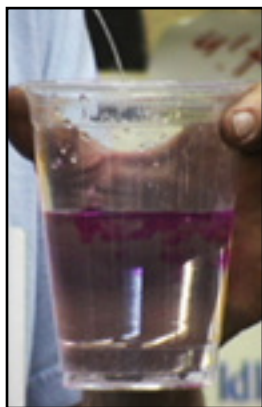
One of the oldest tricks in the book is, a magician will say, "This is plain water," and then they'll make it change colors magically. [Student: How?] He puts in a special chemical. You're not seeing me put in this chemical. That man up in front is merely a figment of your imagination. I'm going to put some of that in there [uses a pipette to add some phenolphthalein solution to the glass of water]. That didn't happen, okay? So now [stirs water with his finger], there's a chemical in there, and it still looks like water. I've got it on my finger, too. What color is my finger? [Student: Brown.] Brown. And purple.

Now, magicians, when they show you their hands, you're not seeing their whole hands. They have a hand they show you -- I'll draw one for you. Here's a magician's hand. There's a magician's hand. And they make these really perfectly built rubber tips they put on their fingers. If you look at their hand, it looks like an ordinary hand, but they glue rubber tips on. The rubber tips fit on there and leave a space underneath. So you can put stuff in that space. Especially on the thumb one, they can fit a whole bunch of really thin silk scarfs under the thumb one. They can also put chemicals under there. So if a magician sticks his finger in something and stirs, he's not just stirring with his finger. He's adding something to it.



Magician's fake fingers.

In this case, we already added the phenolphthalein chemical that I just put in there. Now, if we put in -- let's pretend like this is the magician's



Ammonia added to phenolphthalein solution turns water purple.

finger [holds another pipette containing ammonia] -- skinny finger [drips ammonia into water, where it turns purple]. Purple. You could do like that [stirs water with finger to make entire solution purple] and go "Ha, ha, ha, I have magic powers. I just changed the water to purple. Or violet. Whatever you want to call that." And then somebody in the audience shouts out, "Change it back!" So now he can change it back. He's going to stir with his other finger if it has another chemical in it that changes it back.

At no time does my hand leave my arm [drips vinegar into the cup, then stirs it with his finger, and the water becomes clear again]. There. Ta-daa! It's back. [Student: Can I drink it?] No, if you drink it, you'll get diarrhea.

[Instructor pours some more ammonia into the cup and it turns purple again. Then he pours more vinegar in and stirs, and it turns clear again.] So there is a way to make that happen. That's one of the chemicals we're going to use today.

## Demo #2: "Magician's Trick with Cabbage Juice"

Here is a bottle full of dead -- no, this is blood. This is blood of red cabbages. Red cabbage is purple. Red cabbage juice isn't red either. There's nothing about a red cabbage that's red. If you boil the juice, it's blue. Why do they call it red cabbage? It's because the guy that named it had a very acid sense of humor. *[Pours some juice into a clear plastic cup, then pours it back and forth among three cups until each cup contains about the same amount.]* Does it look kind of bluish to you? *[Students: Yes.]* Blue.



Pouring red cabbage juice.

Okay, we've got some red cabbage juice that's blue, that came from a purple cabbage *[puts the cups on the table]*. Any magi-



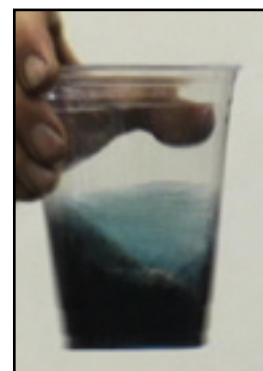
Red, Blue, and Green Cabbage Juice

cian could have ammonia around. So this is ammonia -- ammonia is a base *[pours some ammonia into the first cup of juice and it turns green]*.

This one is vinegar *[pours vinegar into second cup of juice and it turns reddish-purple]*.

So if you're a magician, you can make all these things very simply, and this applies to the experiments you're going to be doing in a few minutes.

What if I mix some of the green stuff with some of the reddish stuff? *[Students: It will turn brown.]* It'll turn brown, right? Let's see if we get brown. Green and red makes a pretty good brown. Let's try mixing it this way *[pours a little of the green liquid into the red liquid and swirls it around to mix it]* and see if we have enough. *[Red liquid turns a darker purple, so Instructor adds more green until the purple turns turquoise.]* What color do we have? *[Students: Green. Blue. Turquoise.]* Turquoise. It's kind of a turquoise, isn't it? So chemical reactions are a magician's friend.



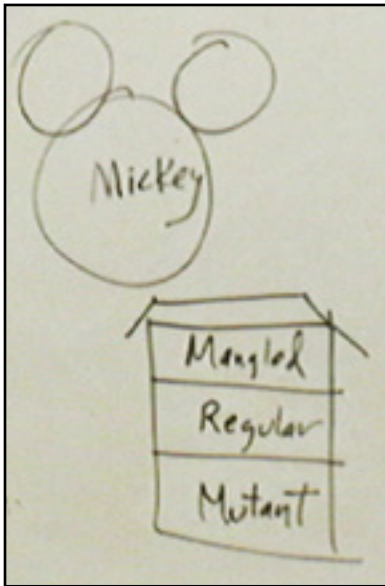
Pouring Green into Red (right) makes Turquoise (far right)



## Interim Story: "The Three Mickeys"

Once upon a time, there was Mickey Mouse. This is regular Mickey here. And Mickey has two brothers. One brother was working with his lawnmower, fell down, and the lawnmower went right over the top of him. Poor Mickey. One of his ears got chopped off. That one they called Mangled Mickey. And the other brother thought a lot. He thought so much that he had his chin on his fingers, and it irritated his chin. Next thing you know, he's got an ear growing on his chin. He's mutated. Mutant Mickey. Three ears instead of one.

They all lived in the same house. It was a huge mansion. On the top floor was Mangled Mickey. On the middle floor was regular Mickey. On the bottom floor was Mutant Mickey. And regular Mickey told the guy on the top floor, "Never ever go visit your brother." And he told the guy on the bottom floor, "Never ever go visit your brother." And they did not visit each other.



Mickey's house.

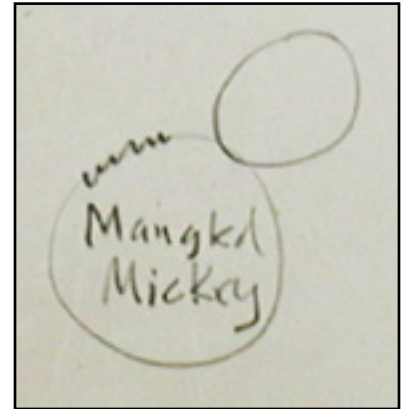
Until one day, regular Mickey went off to make a movie. And Mangled Mickey and Mutant Mickey were left alone. And Mangled Mickey heard horrible sounds coming from Mutant Mickey's room. And he said, "Oh, no! I hear crashing, banging, screams. Oh, it's terrible! He must be getting robbed. It's horrible! I'll go save him." So he jumped out the window, landed on the ground -- splat -- ran into Mutant Mickey's room, and there's Mutant Mickey watching tv with the volume turned up full blast. And he said, "My brother!" And they ran towards each other. But when they got about that far apart [*holds thumb and forefinger about an inch apart*], they both pulled back with their right hand and hit each other -- boom -- right in the nose. And then, one grabbed the other, took him and threw him out the window. And then he ran outside, grabbed him and, threw

him through the wall. They grabbed the sofa and smashed it on each other. They pulled the curtains from the wall, ripped the carpet from the floor, and made big holes in everything.

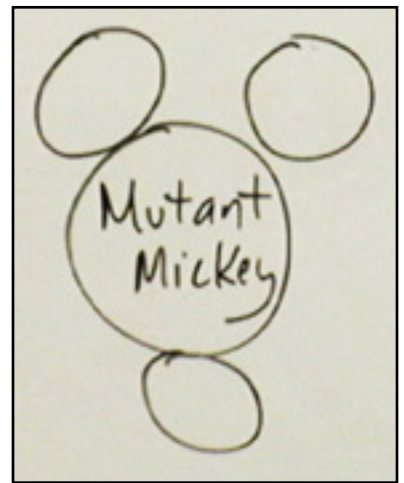


Mutant Mickey's chin ear was torn off.

And then regular Mickey came home. And he looked, and there they were. Mutant Mickey had gotten so beat up, his chin ear was ripped off. Mangled Mickey, being a joker, grabbed his ear and duct-taped it on his own head. [*Student: Well, at least now they're all the same.*] Yes, and they're both smiling because they're idiots. And regular Mickey said, "I told you guys -- never ever go visit each other. And



Mangled Mickey missing an ear.



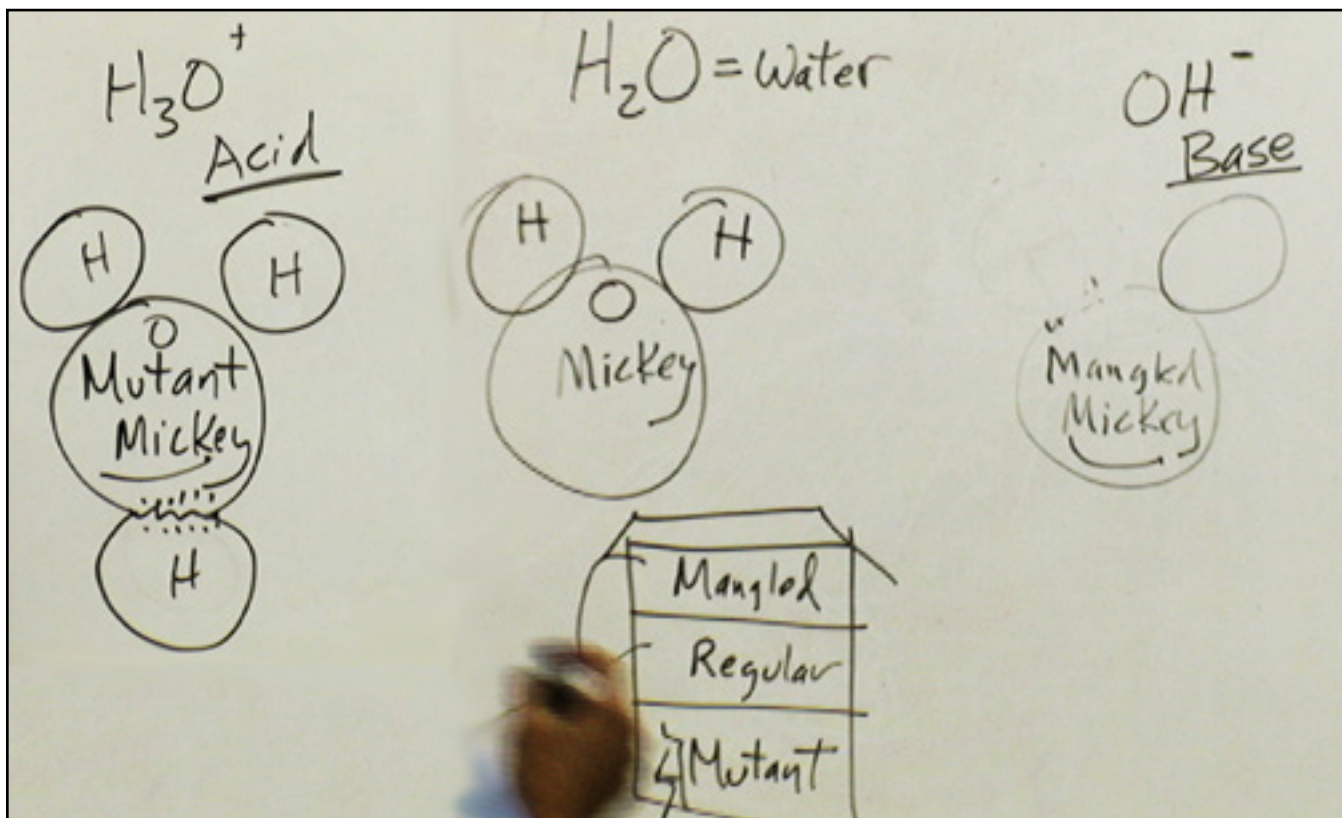
Mutant Mickey with a chin ear.



Mangled Mickey with duct tape.

now look what's happened. You've destroyed the house." And they said, "Oops!" And regular Mickey says, "Now, you Mangled Mickey, take that ear off your head. That's not funny. And give it back to your brother." So he took it off and sewed it back on his brother's chin. There. Now, that is chemistry.

This is chemistry because Mickey's ears have big "H"s on them. And his head has a big "O." [Student: Oh,  $H_2O$ .] Right,  $H_2O$ . And that equals what? [Students: Water!] Water. Mangled Mickey only has an O and an H. They always do it backwards, with a minus sign. And he's something called a base. That's like the ammonia we used. And this guy, Mutant Mickey, he's got an  $H_3O^+$ , and he's an acid, like vinegar. Whenever you mix an acid with a base -- boom! -- things happen. Like baking soda and vinegar mixes together and foam!



Regular Mickey is  $H_2O$  (water), Mutant Mickey is  $H_3O^+$  (acid), and Mangled Mickey is  $OH^-$  (base).

## Demo #3: "Making Fizzy Water"

This is baking soda dissolved in water [*pours some into a clear plastic cup*]. It looks like regular water. [*Student: It wouldn't taste like it.*] No, it wouldn't taste like it. And here's vinegar [*pours some into a second clear cup*] mixed with water.

So now if you're a magician, you say, "I've got two cups of water." They don't know they're not filled with water. You told them it's water, it's got to be water.

And then you go out into the audience and you rest one gently on someone's head. Then you pour the other into it. What will happen? [*Student: It will bubble all over their head.*] Well, the Mutant Mickeys are going to fight with the Mangled Mickeys and create something. Let's pretend like someone's head is right here. He's smiling. And I pour the two together [*pours some liquid from one cup into the other above the imaginary head. It foams up, but does not overflow*], and he doesn't get doused. Well, that's sad. He says, "Oh, man, I want to get doused."

Look at the water, though. We created fizzy water. [*Student: It looks like soda. Can I drink it?*] It looks like soda. Doesn't taste like soda. Here goes the extra [*pours the remainder of the liquid from the first cup into the second*]. So you can get a reaction between those two.



Vinegar added to baking soda solution makes fizz.

## Experiment #1: "Drawing with Color Changers"

We're going to do a couple of experiments. Should we start out with a simple experiment and go to the difficult one, or start with a difficult one? Let's start off with an easy one. Ordinary-looking paper. This kind of paper [*holds up a sheet of goldenrod paper*] was used in a diary by Harry Potter. When you draw on it, something bad appears. You guys are going to draw on it and see what happens. You can draw anything you want on it.

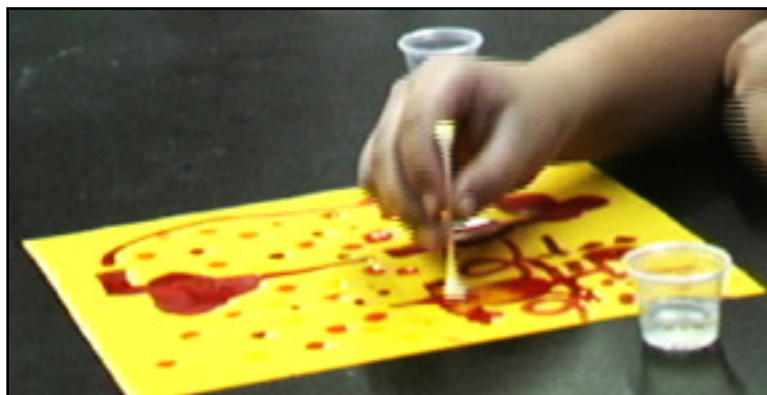
[*Student: We don't have markers.*] We'll give you some markers. They aren't going to be regular markers, though. Spared no expense to buy these paintbrushes [*holds up a Q-tip*]. We had to trek through jungles to find these. You get one of those and a cup that has clear liquid in it. [*Instructor passes out Q-tips and souffle cups with the baking soda solution in them, but doesn't tell students what it is.*] When you get the cup of liquid, which we're telling you is just water, dip your paintbrush in it and draw something. [*Paper turns bright red where the baking soda touches it.*] Save some space because we're going to add some other chemicals to it.



Drawing with baking soda solution turns the goldenrod paper red.



*[After a few minutes, Instructor passes out a second souffle cup containing another clear liquid (vinegar), and students draw with it. The vinegar erases the red lines created by the baking soda solution.]*



Vinegar erases the red lines made by the baking soda.

We haven't done anything stinky lately. *[Instructor walks around with a spray bottle and sprays another liquid (ammonia) in a fine mist on a small part of the students' drawings, which makes the image reappear.]* Now you're going to set those pictures aside and push them to the middle of the table and let them sit for a minute.



Ammonia spray shows red in the lower right corner of the paper.

## Demo #4: "Reveal Invisible Writing"

The assistant has a piece of that same yellow paper in a tub over there. *[An assistant has a large plastic tub with a small amount of ammonia in the bottom and a sheet of cardboard covering it. He takes a half-sheet of the goldenrod paper and lowers it into the tub without touching the liquid ammonia. The paper turns red and some writing appears on it.]*

If you watch it, can you see what it says? What do you think's in the tub? The tub is full of ammonia.

Take your containers and mix them together. See what they do. *[Students mix their baking soda solution and vinegar together and see them fizz.]*

*[Instructors clear away the souffle cups and Q-tips.]*



Ammonia fumes reveal invisible message written in vinegar.

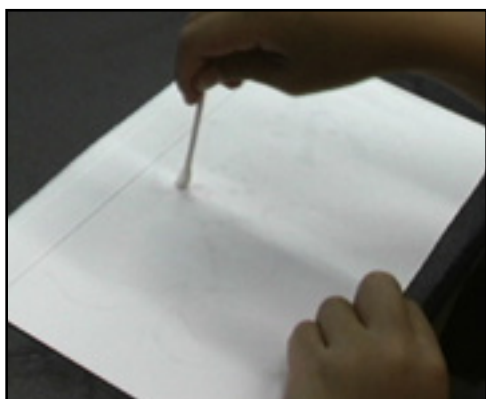


## Experiment #2: "Invisible Writing"

*[Instructor passes out a sheet of thin white cardboard, a new Q-tip, and another souffle cup of clear liquid (phenolphthalein solution).] Get your fancy paintbrush and start drawing on your piece of cardboard. [Drawings appear invisible. Then students bring their drawings outside, where they can dry completely in the sun.]*

*[Instructor sprays a fine mist of ammonia on the pictures, which turns the image purple.]*

*[Students take them back into the sun to dry, which makes the image invisible again. If time allows, Instructor will spray them a second time to make the image reappear.] After you've done it twice, then you can take it back inside.*



Phenolphthalein image looks like water and dries invisible in the sun.



Instructor prepares to squirt a mist of ammonia onto the image.



Ammonia makes the phenolphthalein image purple.

## End of Story

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

So Evil Mister Fred was running around with the squirtgun he got when he was down in the lake, and he was changing everybody's colors. And now they've started fighting with each other. Evil Mister Fred said, "Yeah, this is more like it." And Jack and Jill were saying, "What are we going to do? That Evil Mister Fred is causing endless trouble around here."

And Jill said, "You know, I think I have an idea. Maybe we can change all the colors back the way they were before, and everything will stop." So she called the Acme Store of Everything and ordered another squirtgun called "chemical color restorer." And she was going squirt, squirt, squirt, squirt, squirt, squirt, and wherever she squirted, the colors would come back again. But Evil Mister Fred was faster than Jill, and he would be squirting more things than she could possibly ever return back to zero again. And she said, "That's not working. We've got to try something else."

And Jack said, "Aw, I wonder if we could trick him." So Jack made a big cardboard hill. He put a cave in it. In the back of the cave he put a mirror. And he put a sign on it that said, "Evil Mister Fred, Don't Squirt Me No Matter What! Please, Please, Please Don't Squirt Me!" And they waited to see what would happen.

And Evil Mister Fred went through the town like before. And he came to this cave and he saw the sign that said, "Evil Mister Fred, Don't Squirt Me No Matter What! Please, Please, Please Don't Squirt Me!"

He said, "Oh, ho, ho!" So he ran into the cave, and it was all dark in there. And he was just going squirt, squirt, squirt, squirt, squirt, squirt. And he squirted the mirror. And the Evil Mister Fred went thwoomp! and was sucked into the mirror and disappeared. And Jack and Jill went all around and returned everybody back to their natural colors. And they all lived happily ever after, except Evil Mister Fred.



Jack's cave with a mirror inside and a sign on the front.

## End of Lesson

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