



Teacher's Guide for:  
**Solar Furnaces**

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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Solar Furnaces  
A Rock-it Science Lesson  
Filmed July, 2009

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## Intro Quick Recap:



### Lesson Intro: Fresnel Lenses

- In the days of sailing ships, they needed a way to warn ships so they wouldn't crash on the land.
- They tried various kinds of signal fires: candles, bonfires, glass enclosures, whale oil lamps.
- Fresnel took a curved lense and made stairsteps in it so it was lighter and wouldn't break as easily.
- Then he used separate pieces of glass to make the stairsteps, which improved the quality of the lens.
- Instructor demonstrates various fresnel lenses, showing how they magnify his image.

## Experiments Quick Recap:

### Experiment 1: Experiment with Magnifying Lenses

- Students each get a handheld magnifying glass and look at each other through them to see how the image changes.
- Students get a fresnel lens (1 lens per pair of students) to experiment with, in combination with the magnifying glass.



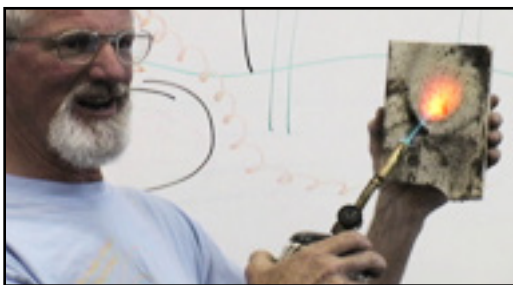
### Experiment 2: Burn Things with a Magnifying Lens

- Students color a sheet of paper with permanent markers, using some light and some dark colors.
- Outside, students use sunlight and a magnifying glass to burn the paper, then a dry leaf, then a wet leaf.
- Remind students to keep the spot of sunlight as small as possible.



## Demos Quick Recap:

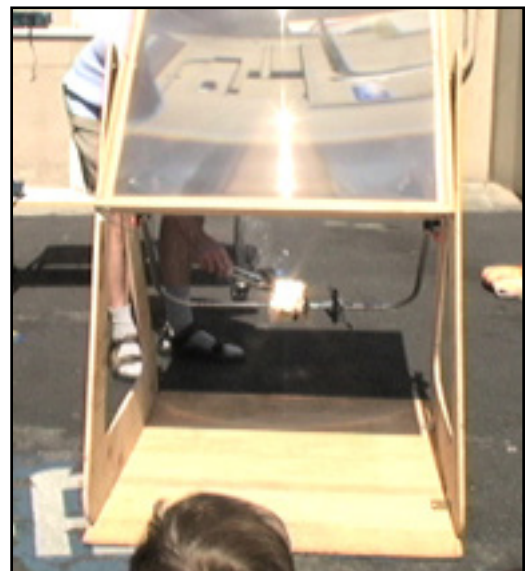
### Demo 1: Try to Burn a Fire Brick



- Instructor uses a propane torch burning at approx. 2,000 degrees to try to burn a fire brick.
- The brick gets hot, but the flame doesn't damage it.

### Demo 2: Burn Things with Giant Fresnel Lenses

- Outside, Instructor sets up a pair of giant fresnel lenses mounted on frames and uses sunlight to burn a piece of wood, a wet sponge, a marshmallow, a penny made of zinc & copper, a penny made of copper only, a piece of lava rock, and a firebrick.



## Equipment List: "Solar Furnaces"

### Items needed for Instructor:

- Giant Fresnel Lenses from projection TVs, mounted in adjustable freestanding frames
- Clamps to hold lens frames in position
- Bath towels to cover giant lenses when not in use
- Medium-size Fresnel Lenses, with various magnifications
- Oil Lamp
- Propane Torch
- Propane
- Fire Brick
- Metal strap, rods, and clamps to attach fire brick to lens frame
- Welder's Mask
- Tongs
- Things to burn in the furnace: wood, marshmallow, sponge, pennies (pure copper and composite), lava rock (pumice)
- 12-oz Clear Plastic Cup
- Water
- Rolling Cart

### Items needed for Students:

#### Consumables (per student):

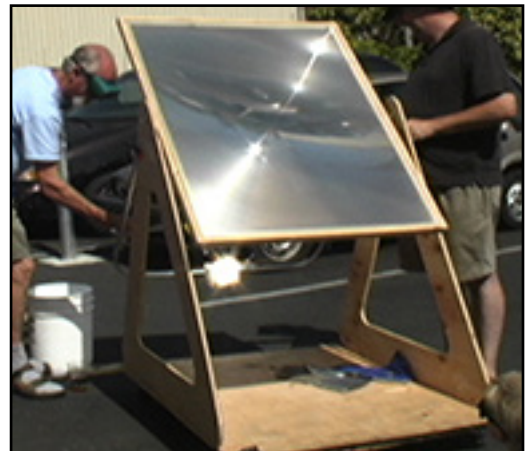
- 12-oz Clear Plastic Cup
- Water
- Sheet of White Paper

#### Other:

- Magnifying Glass with handle, approx. 4" diameter
- Lens, fresnel, plastic sheet, 1 per 2 students
- Markers, Permanent, Colored
- Welder's Goggles with flip-down light shield

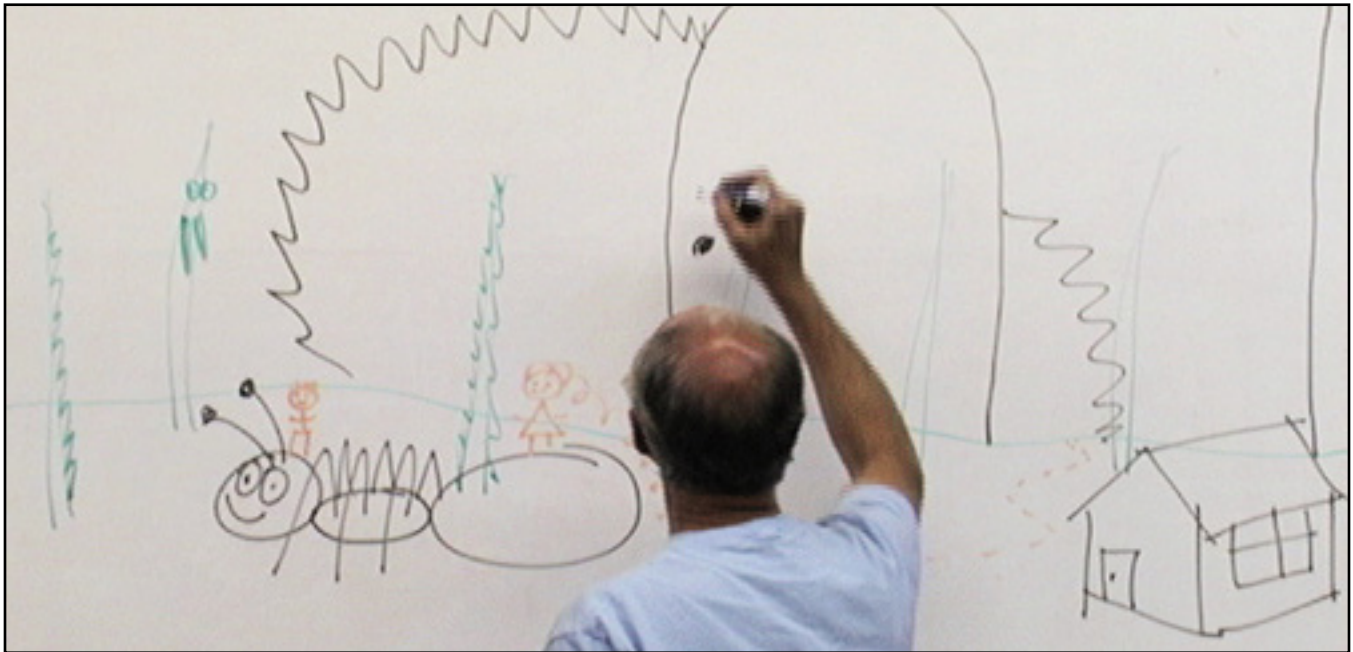
### Prep Work:

- Wash goggles before class
- Clean magnifying glasses and lenses
- Assemble giant fresnel lens frames (The lens comes from an old projection TV. Contact Rock-it Science for information about building the wooden frame.)
- Attach Fire Bricks to lens frames
- Check the weather (sunlight required)



Welder's goggles with flip-down light shields.

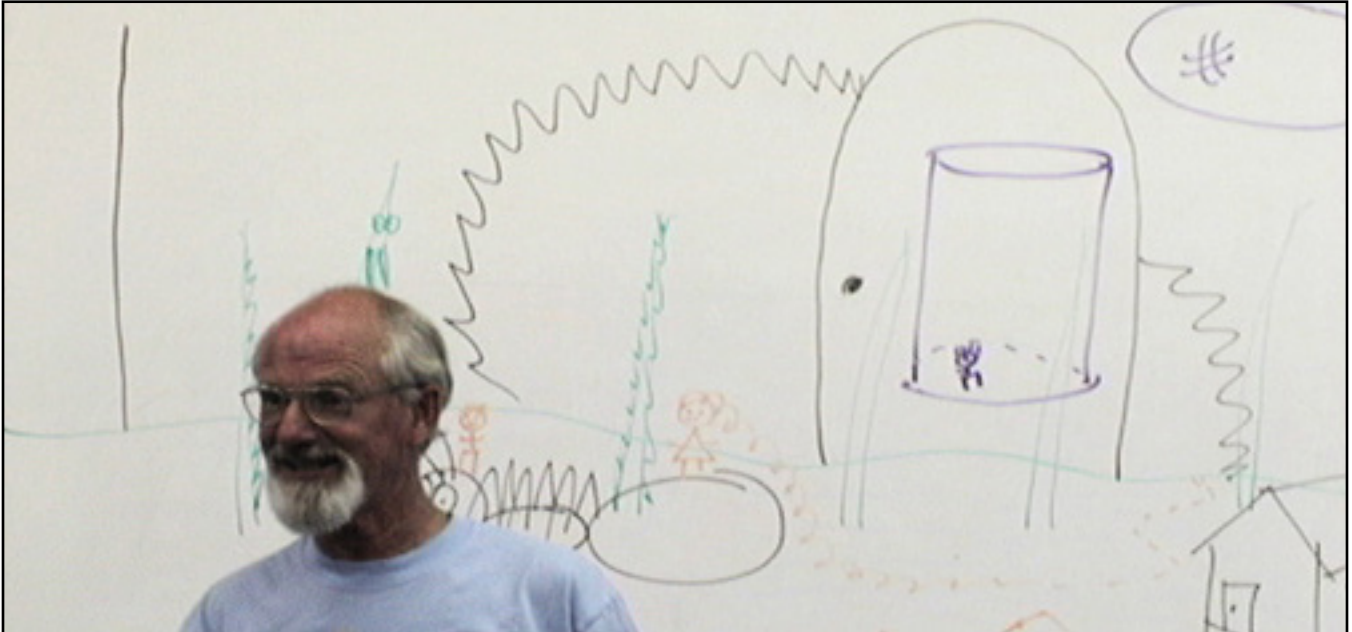
## Story Recap: "Jack and Jill are Ant-Size"



### Part 1:

- Jack and Jill have shrunk themselves down to the size of an ant.
- They're riding the ants, having ant rodeos, riding through the blades of grass, etc.
- They decide to go and live next to a big cliff.
- Then an earthquake happens, caused by a minion foot that crashes down on the earth and flattens the grass.
- Jack & Jill realize the cliff is actually Evil Mister Fred's castle.
- They enter through a hole in the wall and see Evil Mister Fred yelling at his minions.
- Jack & Jill each climb into one of Evil Mister Fred's ears and start whispering, telling him to be nice to the minions.
- This causes Evil Mister Fred to have nightmares, and he thinks he's going crazy.
- Finally one day, Jack jumps out of Evil Mister Fred's ear and lands on the table. Evil Mister Fred thinks he's an ant and is about to squash him, until Jack screams.
- Thinking it's a talking ant, Evil Mister Fred traps Jack under an overturned glass and plans to take him to the circus so he can make lots of money.

## Story Recap (cont.)

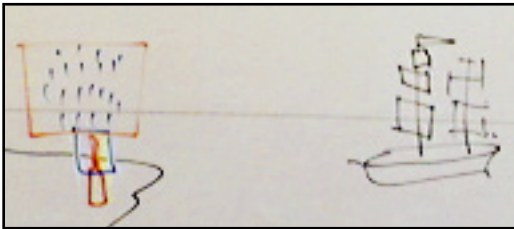


### Ending:

- Jill, still inside Evil Mister Fred's ear, tells him he must find a chocolate-covered doughnut.
- She tells him he can find one outside.
- Evil Mister Fred walks outside, leaving Jack on the table under the glass.
- Jack had ant strength, so he lifts up the rim of the glass and gets out.
- He runs outside, calls the Acme Store of Everything, and orders a giant fresnel lens.
- The lens hovers in the sky like a flying saucer above Evil Mister Fred and focuses the sunlight on his head.
- Jack warns Jill to get out of Evil Mister Fred's head, and she jumps out and onto the ground.
- Evil Mister Fred's hat bursts into flame, his hair catches on fire, and he runs away screaming.

## Transcript: Introduction

A long time ago, people sailed ships with big sails, and they had steering wheels on them, and the steering wheels controlled a big old piece of wood that hung around the back like a fin and pointed it this way and that. They called it a rudder. And they would sail during the daytime and they would sail during the nighttime. And a lot of time, they crashed into the land and their ship sunk -- glug, glug, glug, glug. And they all had to swim away. And they said, "What we're going to do is, we're going to set up some lights on the land." So there's some land out here, and some ocean out there, and ships coming by with their sails and their big cannons and their flags and stuff. They would put some lights out here on the land to warn them, so at night they wouldn't just crash into the land.



Sailing ship with lights in a glass box.

In those days they didn't have much in the way of lights. You could put a candle out there, but as soon as the wind would blow, the candle would go out. So they put some glass around the candle to help keep the wind from blowing it out. They put the candle in a nice glass box. Now the wind didn't blow it out, so they said, "Okay, this is great." But the guys out at sea couldn't see the candle. It was too small. They said, "No problem. We'll put a hundred candles out there." So they put out a

hundred candles, and even a hundred candles wasn't that good. So they said, "Forget that. We'll build a bonfire." So they built these big fires out there, and the wind couldn't blow out the big fires, and people could see them pretty well. But if it rained -- uh, oh -- fire went out, ships went crash! So they put a big glass box around the bonfire. And then it wouldn't go out, and they could see it from a long ways. But a bonfire requires lots of wood. And there were places out there where there wasn't enough wood. So they said, "We need an efficient way to make this work."

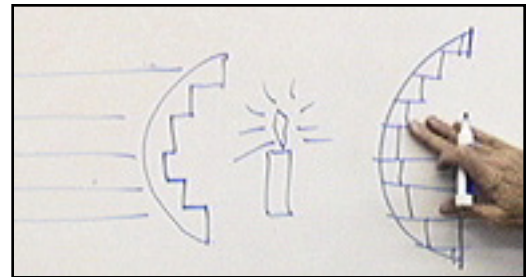
In those days, they killed whales, and they cut the whales all to pieces. And they took the fat of the whales, and they put it in a great big black pot, and they lit a fire under it, and the fat turned into oil. And they scooped off the best part of the oil, and they used that to make candles and lanterns. So if you took one of those kinds of things, a lantern looks kind of like this [*holds up a hurricane lamp*]. They'd fill the bottom with oil and then have a piece of cloth inside. There's a wick in there, and the wick can go up and down like this. And you can take this off [*removes glass chimney*] and you can light the wick, and you can put that back on, and it would make a nice flame. But you still couldn't see it from a long ways away, because the light goes out this way, it goes out that way, it goes out everywhere except straightways.

And there was a French guy, he wasn't a physicist, he wasn't a person that studies much of anything, except he had this brilliant idea. He said, "I know how I can make light bend and go the way I want it to." Because he'd looked at things like pieces of glass with curves on them. And he'd take a big curved piece of glass like that -- this is a magnifying glass -- and you put a candle or any kind of a flame behind it. The light



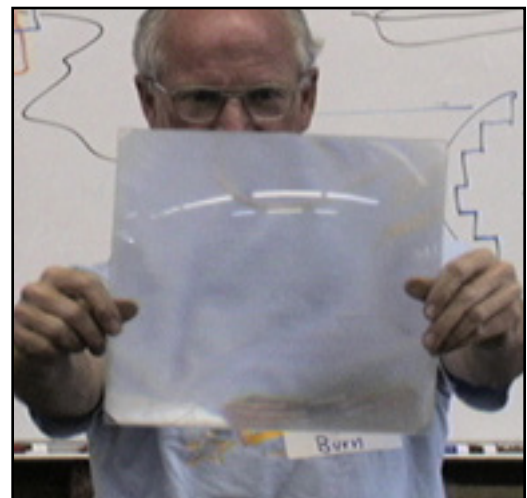
Hurricane Lamp

can be focused so that it works more like a straight beam rather than one that just spreads everywhere. But a lens this big in those days was really hard to make. Big chunk of glass, and as it cooled it always broke. He said, "Oh, man, every time we make one of these it just breaks." So he said, "Well, let's try a trick. Let's kind of hollow it out. Let's go stepwise here and see if that works." So they hollowed it out, and it didn't break, but it didn't work very well as a lens either. So then he said, "Rather than hollowing out the back side, let's change the front side." So he took this curvy shape with a flat back and he said, "Let's just pretend like we sliced the lens up in a whole bunch of pieces, like that. And then we'll cut off the back of that piece, and the back of that piece, and the back of that piece, and the back of that piece, and the back of that piece, and the back of that piece, and the back of this piece. And then we'll throw away all this glass and restack them." And his last name was Fresnel. It's pronounced "fren-ELL."



Fresnel lens, stepwise and sliced.

And the thing he invented looked like -- here they are. This is one of his lenses. Is my head right side up? Yeah? Okay, we'll try another one. And another one. And these are made this way, where they cut the weird back out of it and restacked the pieces. *[Holds up another lens.]* Okay, is my head right side up? Yep? How can I make my head upside down? *[Student: Turn it around.]* Okay. There. Now, is my head upside down? *[Students: No. Flip it over.]* Flip it over. Okay. Upside down head? *[Students: No.]* No. How can I make my head upside down? *[Student: If you bend it . . .]* If I bend my head, it'll be upside down. There's another way to do it, though. *[Student: Angle it!]* Okay. *[Student: No. The other way.]* No. There's another way to do it. *[Student: Turn it so it's a diamond, sort of.]* Diamond. How about if I go like this *[moves lens further away from his face]*. There's somebody, right about there. *[Student: Gigantic.]* Gigantic. Is it right side up or upside down? *[Students: Right side up. Upside down.]* I want it to be upside down. *[Moves lens out to arm's length.]* I need longer arms. *[Student: It's upside down.]* It should be upside down now. It's upside down to the people in the back, but right side up to the people in the front. Now, this is a magnifying glass, right? Because you can make things bigger. In fact, what if I hold it right here *[puts lens in front of student's face]* and then I hold it right there *[puts it in front of the face of another student who is facing the first one]*. And I could make it go like that *[places lens between pairs of students, moving it back and forth between their faces]*. *[Puts lens directly in front of the video camera and moves it back and forth.]* Makes me dizzy, I don't know about you.



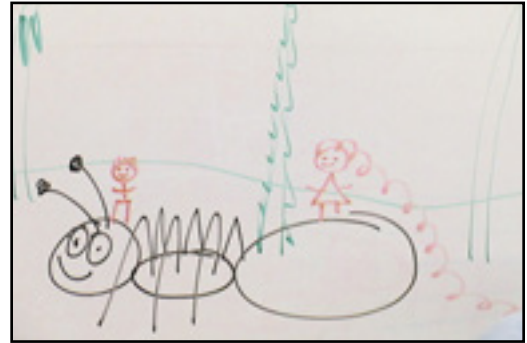
Upside-down image at arm's length.

Okay, well today we're going to experiment with this kind of lens and with other kinds of lenses. But first we need to divide up into groups and have some crazy stories.



## Story: "Jack and Jill are Ant-Size"

Once up a time Jack and Jill were living with ants. And if you're living with ants, grass looks really big. Jack and Jill had to put themselves into shrinkifyers. Well, here's a blade of grass. Here's some more grass. Grass really isn't all that close together when you get down low. And did you know that grass has teeth? Yep, if you go play with a blade of grass, it's got teeth. Usually it's on the edges like that. Some of our grass has teeth like this. You just never know where it's going to have its teeth. And we need an ant down there. How many pieces are there in an ant body? *[Students: Three!]* Three? Is there a head? And with some antennae, maybe? *[Student: And an abdomen.]* Okay, is his abdomen big or small? Not so big. And then a body part. And the legs are usually attached to the abdomen, I think, like that. There's an ant. Okay. And Jack and Jill made themselves small. So here's Jack. Here's Jill. And they're riding ants around, doing ant rodeos, playing ant games, jumping from one ant to another as the ants are racing all over the place.



Jack & Jill Riding an Ant

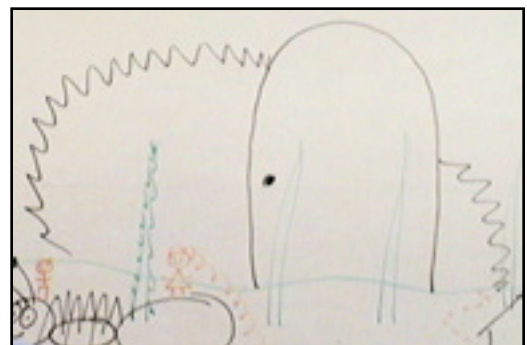
For their size, ants are incredibly strong. Ants can climb straight up cliffs, they can jump from place to place, they can pick up incredibly heavy objects. And suppose Jack and Jill had a house over here, and the ants are on the move. They're migrating from one place to another, and Jack and Jill want to have their house moved. Well, all they have to do is tell an ant, and the ant can pick up the whole house and walk away with it just carrying it in his front paws. He's got four other paws to work with. And they're going up, and the new place where they moved happens to have this really tall cliff next to it. And the cliff has an opening like that. And they don't know what it is. It's so huge, when they look at it, it just looks like it goes on forever and ever and ever. And they were busy playing out there in the grass, and all of sudden there was an earthquake. Kaboom! Kaboom! Kaboom! And they heard thunder -- Arrrrgggghh! To their ears, they couldn't understand what this was. A huge shadow came across the land. And then something -- they didn't know what it was -- a something huge came and crushed a whole bunch of grass and went away. It was a minion footprint.



Jack & Jill's House

And Jack and Jill said, "Oh, no! That big thing, whatever it is, must be Evil Mister Fred's castle. And we're tiny, and they could step on us and not even know it. We'd just be squished on the ground. So we'd better find a safe place to go instead."

So Jack and Jill and their ant friends went inside Evil Mister Fred's castle. Pretend like this is a hole in the wall. And Evil Mister Fred was in there, but he was a giant huge guy. And Jack said, "Oh, boy, let's play some games on Evil Mister Fred." So Evil Mister Fred was sitting in his chair giving orders to the minions: "Do this! Do that! Don't do this! Don't do



A Hole in the Wall of the Castle

that! Stop that! I'm going to punish you for that! Into the dungeon with you!" All these orders. And Jack sneaked up on Evil Mister Fred, climbed up his chair, went around to his ear, climbed in his ear, and then he said, "BOO!!!" And Evil Mister Fred jumped so high he hit his head on the ceiling. And Jack said, "Yeah, I like this." And Evil Mister Fred was trying to clean out his ears, because he thought there was something walking around in his ears. And Jill said, "Wow! That Jack. That's so much fun." So she climbed in his other ear.

And then they were really quiet. They didn't say anything at all. And they felt like Evil Mister Fred stopped moving, and they wondered, "What's he doing?" Then they realized he was sleeping. And Jack said, "Evil Mister Fred . . . tomorrow morning when you wake up, you will give the minions good food to eat. And you'll be nice to them all day long." And Evil Mister Fred thought he was having nightmares, and he was rolling over and he said, "No! No! No! Can't do that!" And Jack and Jill were trying to trick his brain so he'd be nice the next day.

Well, this went on for day after day, and Evil Mister Fred couldn't get any sleep, he was dragging around, he had a headache, his eyes were all red and bleary, he didn't know what was going on. Then one day Jack got out of his ear and was playing around on the table getting something to eat. And Evil Mister Fred saw him. An ant on his table. He said, "Don't like ants!" And he grabbed his cup like he was going to squash Jack. And he goes crash! -- and Jack dodged out of the way. Crash! And Jack dodged the other way. And Jack said, "Stop that!!" And Evil Mister Fred heard this little tiny voice saying, "Stop that!" He said, "What? A talking ant. Wow! I could make a million dollars with the circus with a talking ant."

And now he's trying to catch Jack. He turned the cup over, and now he's trying to put it on top of Jack to catch him. And eventually, sure enough -- Jack's trapped under the cup. And Evil Mister Fred carefully slid a little piece of paper under the edge of the cup, and now he turned it over, and he's got Jack in a jar. Ho, ho! Jill is still in his ear. Jack is trapped in the jar. And he says, "Now I've got it. Ant, talk to me!" And Jack went [*keeps mouth tightly closed*]. He says, "Come on, ant, say something." Rattle, rattle, rattle. And Jack wouldn't say a thing. And Evil Mister Fred said, "If you don't talk, I'm going to squish you!" And Jack said, "Don't do that!" So Evil Mister Fred said, "I knew it! You can talk! I'm going to put you on tv. I'm going to be rich." And Jack says, "I won't talk on tv." And Evil Mister Fred took his finger and he put it near Jack and he said, "Oh, yes, you will." Now, if you were Jack, or Jill, and you wanted to somehow get yourself out of this terrible situation, what would you do?

## 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:

### Experiment 1: Magnifying Lenses

And the first experiment is going to be with ordinary magnifying glasses. We'll see if we have enough so that everybody gets a magnifying lens. When you get a magnifying lens, you can of course look at your fingers and stuff and see how much they magnify. But then, look to your neighbor, and see how your neighbor changes when you move your lenses closer or further from each other, and closer or further from your own eyes. You're just going to move them back and forth. See if you can look into their brain. Look right at their eyes, and see if you can see into their brain. And if you look into their brain and find nothing there, that might explain a few things. If you look into their brain and find a computer with a whole bunch of flashing lights, that might also explain a few things. What do you think? *[Instructor passes out a magnifying glass to each student and they experiment with them.]*

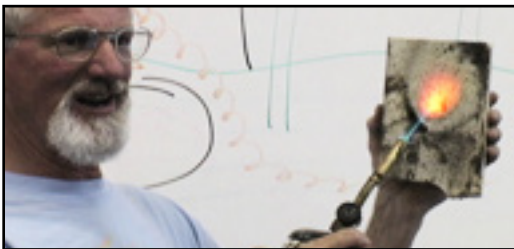


Trying out magnifying glasses and fresnel lenses.

Here's a magnifying glass with the little lines on it. *[Passes out fresnel lenses, one per pair of students, and they experiment with them, alone and in combination with the magnifying glasses.]*

## Demo:

### Demo 1: Try to Burn a Fire Brick



Propane Torch and Fire Brick

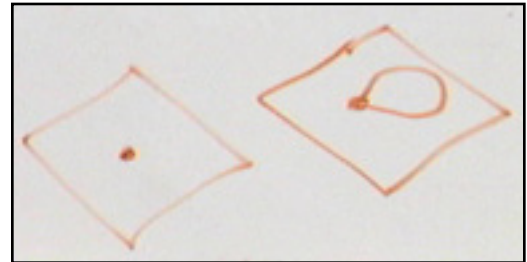
Here's a brick thing and a propane torch. We're going to see if we can burn the brick with a propane torch. This torch burns at 1,950 degrees. You can see that it's making it orange. Is it melting the brick? *[Students: No. Yes.]* Do you see the brick dripping? *[Students: No.]* Is it forming a hole in the brick? *[Students: No. Yes.]* Can you see the hole in the brick? *[Students: No.]* So it's not forming a hole in the brick. Is it burning my hand? *[Students: No.]* Okay, we're using this as a comparison.

This is about 2,000 degrees, and it's not melting the brick, it's not burning a hole in the brick. Do you think you could burn a hole in the brick with your magnifying glass? *[Students: Yes. No.]* *[Student: When you put the flame behind the magnifying glass.]* Oh, maybe put the flame -- what's a bigger flame than this? *[Student: The sun.]* Ah, the sun. *[Student: How about the lights?]* The lights don't have anywhere near as much energy as the sun. *[Student: Let's see the brick.]* Doesn't look any different, does it? But it's really hot.

## Experiment:

### Experiment 2: Burning Things with Magnifying Lenses

Now, if you want to burn something with a magnifying glass, the sun needs to go through it and form a little dot. So suppose you're trying to burn a hole in a piece of paper. When you hold your magnifying glass over it, and you see a little dot with a tail that looks like that, this tail is extra sun energy that isn't being focused at the dot, and your paper might not burn. If we can focus it so that you see just a perfect little round dot, then your paper will burn. If you have the sun behind you, and you're holding your paper like this and your magnifying glass like that, chances are it won't work. Because you'll be in your shadow.



The focused dot should look like the one on the left, not the one on the right.

If you have the sun in front of you, and you hold your paper like this and your magnifying glass like this, you might burn a hole in your shirt. If you're sideways, with the sun to you sideways and have the paper pointing at the sun and the magnifying glass pointing at the paper, it might work. While you're doing it, it makes a really bright spot. Today it's not too bright, so it's probably not too much of a problem. But we're just going to take the glass magnifying glasses, not the plastic ones, outside. We're going to give you pieces of paper and cups of water. Why do you suppose we're giving you cups of water? *[Student: If it catches on fire.]* Yeah, if your paper catches on fire, you'll have this fire extinguisher. You're going to work by someone else, so there'll be one cup of water for every two people. So sit by someone else. When you get a cup, go fill it up in one of those buckets over there. *[Instructor passes out paper and permanent markers.]* I'm going to give you a piece of paper, and you're going to draw on a piece of paper using a couple of light colors and a couple of dark colors. Don't get your paper wet. Some light colors and some dark colors. When you go outside, you're going to shine the magnifying glass on the light colors and the dark colors and see what happens. *[Students color their papers.]*

When we're outside, we'll give you some goggles. These are your super-duper blind guy goggles. They flip up so you can see, and then they flip down and you're blind. This is always a good thing. And if you feel that the dot you're looking at is too bright, you just flip them down. You might be able to see the dot, and you might not. So come over here and we'll give you some blind guy goggles. Bring your cup and your paper with you, and your partner. After you get it, you can go out in the parking lot. *[Students go outside, sit on the ground and try to burn their papers with the magnifying glass.]*



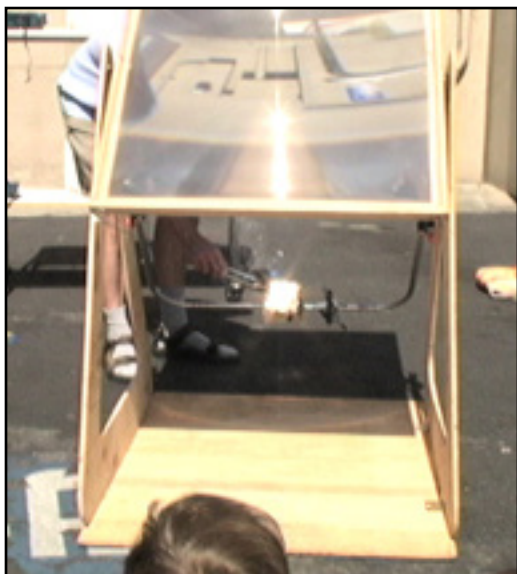
Burning Paper with Sunlight

If you've already burned your paper in a bunch of places, go over there and get a dry leaf and bring it back. You can also try to burn your cup. *[Students try to burn a dry leaf or their cup.]*

Okay, everybody go and get a green leaf from over there by the fence and bring it back. *[Students try to burn a green leaf.]*

Okay, time's up. Put your leaves and your pieces of paper in the blue garbage can here. Set the magnifying glasses so you don't drop them in the magnifying glass box. Keep your goggles.

## Demo:



Giant Fresnel Lens in a Tilttable Frame

### Demo 2: Burning Things with Giant Fresnel Lenses

*[Keep giant lenses covered with towels until ready to use.]*

You're going to have to be where you can see what's going on, on these little bricks. But you cannot be behind them, you have to be in front of them.

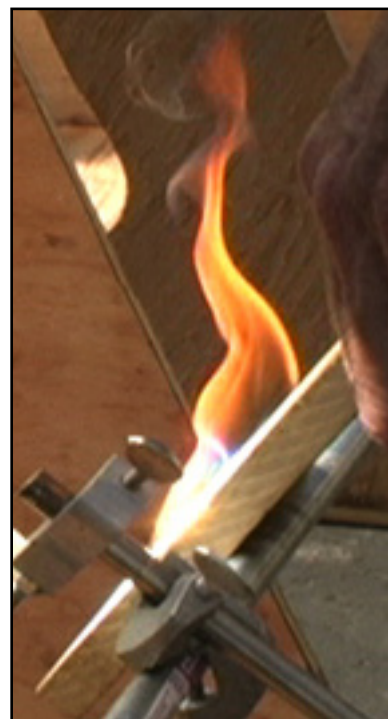
These are just bigger magnifying glasses. We have a medium-size one and a larger one. See here, the dot is huge. See this lit-up area? We need to make the dot smaller. Put your goggles on if you're going to watch the dot. First we'll tilt it up. There, now our brick is getting toasted. We're going to set this one up as well.

Here we have a piece of wood. Can you see this wood through your goggles? *[Students: No.]* You can flip them up to look at the wood. Just flip up your goggles and you can see what

we're going to burn. First thing is a piece of wood, okay? Then you can flip your goggles back down. And can you see the bright spot from where you are? Okay, we'll put the wood where the bright spot is, right there. See how big the dot is? It's kind of big, but . . . Do you see any flames with your goggles? *[Students: Yes. No.]* Okay, you can flip your goggles up and look at it up here and see that it burned this side. Do you see that it also went all the way through the wood? Yeah, this dark spot is where it burned through. We'll just put it in there a little bit longer. Flames. And now you can see the other side is all black, burned all the way through the chunk of wood.

We'll try it with this guy *[puts a piece of wood on the second furnace]*. This one needs to be modified. Focus point is right there. Can you see that from where you are? Okay, we'll take it out. It's just starting to get brown on the other side. Flames? This one isn't quite as hot as the other one is today. This one is just starting to come through now. See the X mark on it? There's some dirt on the lens or something.

So if you want to light wood on fire, that's a good way to burn wood. You can flip up your goggles. Now let's try . . . we'll pour some water on our wood so it won't be so hot. That looks good.



Burning Wood with Sunlight

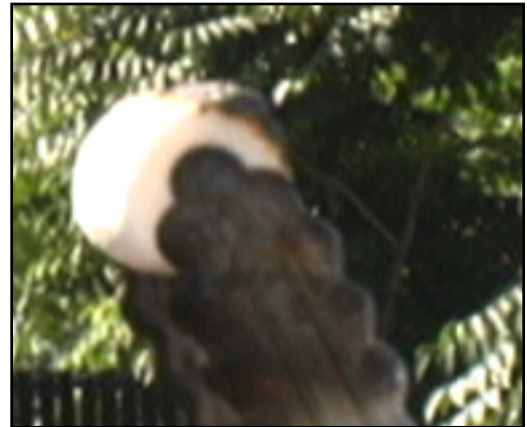
Let's try a marshmallow. Does that look like a marshmallow? It's a stale marshmallow. If you look at this brick with your goggles, the light has melted a hole in our brick. Remember we put the 2,000 de-

gree torch on it, and it did nothing to the brick? The sun just melted a cave in our brick. There's that marshmallow. Now, the marshmallow, is it all burned and exploded, or is it just -- *[Student: On the other side.]* The other side was near the brick. The side the sun was shining on isn't burnt, is it? The marshmallow's so white, it reflects most of the sunlight. The side facing the brick is all burned because the brick was so hot, it gave off a red light and toasted the marshmallow in the back side. Let's stick it back in the sunlight. There it goes. We'll leave it longer this time. *[Marshmallow starts to flame.]* Oh, poor marshmallow. Blackened marshmallow. Let's try it with this guy *[moves marshmallow to second furnace]*. We'll just set it right there. There you go, little marshmallow. Have a good time. Burn, marshmallow. It's growing. It's getting bigger. Our marshmallow is turning into pure carbon. Yummy. Shall we take it off and see what it looks like? Now we have a black marshmallow. *[Places marshmallow in cup of water.]*

Let's try a sponge. Shall we get it wet first? Yeah, let's make it wet. Here's a wet sponge. Put the goggles down. Look how long it lasts. *[Student: Look at the water coming out.]* Yep, it's making steam. Sizzle. Evaporating. If you want to protect yourself from super-hot sun, you should cover yourself with sponges. Look at that. All that time in there, and the sponge is hardly damaged at all. It's probably kind of hot. Let's put it where our marshmallow was sitting and leave it there for awhile. We'll cook our sponge.

Let's put a penny on this one. There. The brick is smoking. We put a penny sitting where the brick is. What's the penny doing, can you see it? Our poor penny is turning into smoke. That penny is a new penny. It's made out of zinc and copper. I'm going to find a penny that's an old penny that's made out of pure copper, and we'll throw that in there. Okay, now we're going to put on the copper penny. This one's pure copper, it should have no zinc in it. There he goes. This is Abe Lincoln. There's Abe. Oh, Abe's face just melted. Poor Abe. Now Abe has turned into a drip. Oh, man. Abe has melted completely away. Aww, bye-bye, Abe.

Now, we're going to put our lava rock on top of where Abe was sitting. And let's see if we have enough heat to melt it. Oh yeah, it's melting. It's turning into lava. The rock is bubbling. I'm going to melt a little bit deeper hole in it. The lava is starting to flow. It's dripping. Think of the people down below the volcano. The potato chips in their cupboard are now going phoom! Okay, it's melted. Don't touch it this time. Now you can see the difference. The rock has turned a darker color, and it's all melted. Okay, there's our melted rock.



The White Marshmallow reflects the sunlight, so it doesn't burn right away.



Steam Rises from the Wet Sponge



Lava Rock Melted in the Center.

So we melted marshmallows, we burned wood, melted pennies, we burned a sponge. I think the sponge is dead -- we burned the sponge. It smells really bad. *[Student: Burn the cup of water.]* Oh, he wants to burn a cup of water? *[Holds cup of water over fire brick.]* The brick is melting it. The light usually goes right through water, it just sits there. Now I think we better go back inside and finish our story.

## End of Story

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

So Jack is inside Evil Mister Fred's ear, Jill is still outside somewhere. *[Student: Jack is outside.]* Oh, did Jack get outside? That's right, Jack is under a cup. Let's put Jack under a cup. There. There's Jack under the cup. And Jill is outside somewhere. *[Student: No, she's inside.]* Oh, is she still inside Evil Mister Fred's other ear? Oh, good. That'll make it easier for us. So Jill is in his other ear and she can talk to him.

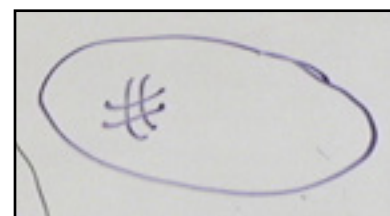


Jack under Cup

And she says, "Hello! I'm Jack, I'm inside the cup. You can hear me now. I'm inside your brain, too. Ants can communicate with each other. They have this connection, and now Jack inside the cup can tell your brain what to do." And Evil Mister Fred said, "No, he can't. Nobody can tell me what to do." And Jill said, "Yes, he can. You have a deep desire for a chocolate-covered doughnut. Think . . . chocolate . . . doughnut." And Evil Mister Fred said, "Oooooohhh! Dough . . . nut!" And he started looking all over the castle for a doughnut.

And Jack is under the cup. Well, ants have incredible strength, and so does Jack when he's small. He got to the edge of the cup, and he lifted it up and got out from under it while Evil Mister Fred was searching for a doughnut. And he said, "Jill, tell him to go outside." And Jill said, "There's chocolate-covered doughnuts outside!" And Evil Mister Fred ran outside and Jack grabbed onto his shoe as he walked by. And now Jack and Jill are outside with Evil Mister Fred.

And Jack said, "Hang on." And he called the Acme Store if Everything and ordered a giant magnifying glass up in the air. What should we call it? A flying saucer magnifying glass. He said, "Jill, run for your life!" So Jill ran out of his ear, jumped onto his shoulder, down his arm, and off into the grass. And Jack ran into the grass, too. And the giant magnifying glass was hovering up in the sky like a big jellyfish. And Evil Mister Fred is still searching for a chocolate-covered doughnut. And the magnifying glass focused on Evil Mister Fred's hat, and he couldn't figure out what was going on. He felt hot all of a sudden. And then his hat went pfffft! into flames, and his hair caught on fire, and he ran away screaming, "Ahhhhhhhh!" And everybody lived happily ever after, except Evil Mister Fred.



Flying Saucer Lens

## End of Lesson

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