



Teacher's Guide for:
Lasers and Mirrors

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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Lasers and Mirrors
A Rock-it Science Lesson
Filmed July, 2009

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(No Intro -- Lesson begins with the story)

Demos Recap: "Mirrors and Rainbows"

- Set up a mirror near the building entrance so that it reflects a spot of sunlight on the classroom wall. Tell the students to notice its location and see if it moves later on.
- Tell students about a carnival Fun House, where they have weird mirrors.
- Show students a large flexible mirror and bend it various ways to show how it distorts the image.
- Ask students to predict which way to bend the mirror in order to make someone look skinny.
- Each time you bend the mirror a different way, walk around with it so each student can see how their own reflection changes.
- Stores use mirrors that are slightly bent to make the customers look skinnier in their dresses.
- Hold a fresnel lens in front of your face to make yourself look really big. Ask students how you could use the lens to make yourself look upside-down.
- Try a couple of different lenses until you get one that makes you look upside-down.
- See if the spot of reflected sunlight has moved. Ask the students why.
- Put various glass and plexiglass objects in the path of the sunlight to see if they make rainbows: a cylinder, a cube, a ball, a triangular prism, a faceted crystal, a diffraction grating, and a CD.



Distorted Reflection



Upside-down in a Fresnel Lens.



Sunlight on Wall



Rainbow from a Prism.



Diffraction Grating

Experiment Recap: "*Lasers and Mirrors*"

- Give each student two plastic mirrors, about 6" x 6".
- The objective is to give themselves a million eyes, cut off the top of their head, and make a tunnel that looks like it goes all the way through the tabletop.
- After students experiment with the mirrors for awhile, tell them to try to make everyone else look upside-down.
- Then have students work in groups of two or more to create a mirror house, with the shiny sides inwards.
- Pass out a sheet of paper to each student and tell them to draw a bug.
- Have them use their two mirrors to make one bug become five bugs. They do this by holding the mirrors up like the open pages of a book.
- Turn off lights and shine a laser pointer into each student's pair of mirrors, making patterns of light as the student slowly opens and closes the mirrors.



Experimenting with Mirrors



Everyone looks upside-down.



Making a Mirror House.



Multiplying a Bug.

Equipment List: "Lasers and Mirrors"

Items needed for Instructor:

- Mirror on a tilting standup frame (shaving mirror), about 6" diameter
- Mirror, flexible "fun-house" style, about 2 ft x 4 ft
- Lenses, Fresnel (2)
- Prism, Triangular
- Plexiglass Shapes -- cylinder, cube, sphere
- Crystal Sphere, Faceted, about 2"
- Diffraction Grating, about 8" x 10"
- CD
- Laser Pen

Items needed for Students:

Consumables (per student):

- Paper, white, 1 sheet

Other:

- Mirrors, plastic, 6" x 6", 2 per student
- Markers, Colored Permanent

Prep Work:

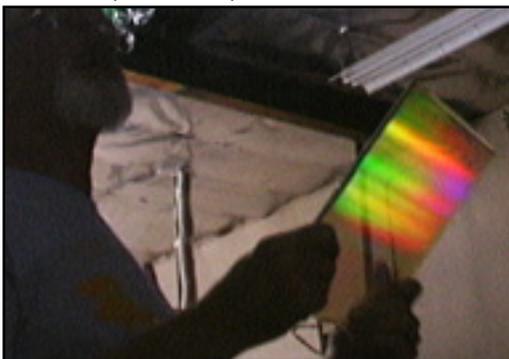
- Clean the mirrors.
- Check battery in laser pen.



Cylinder & Sphere



Cube & Faceted Crystal



Diffraction Grating

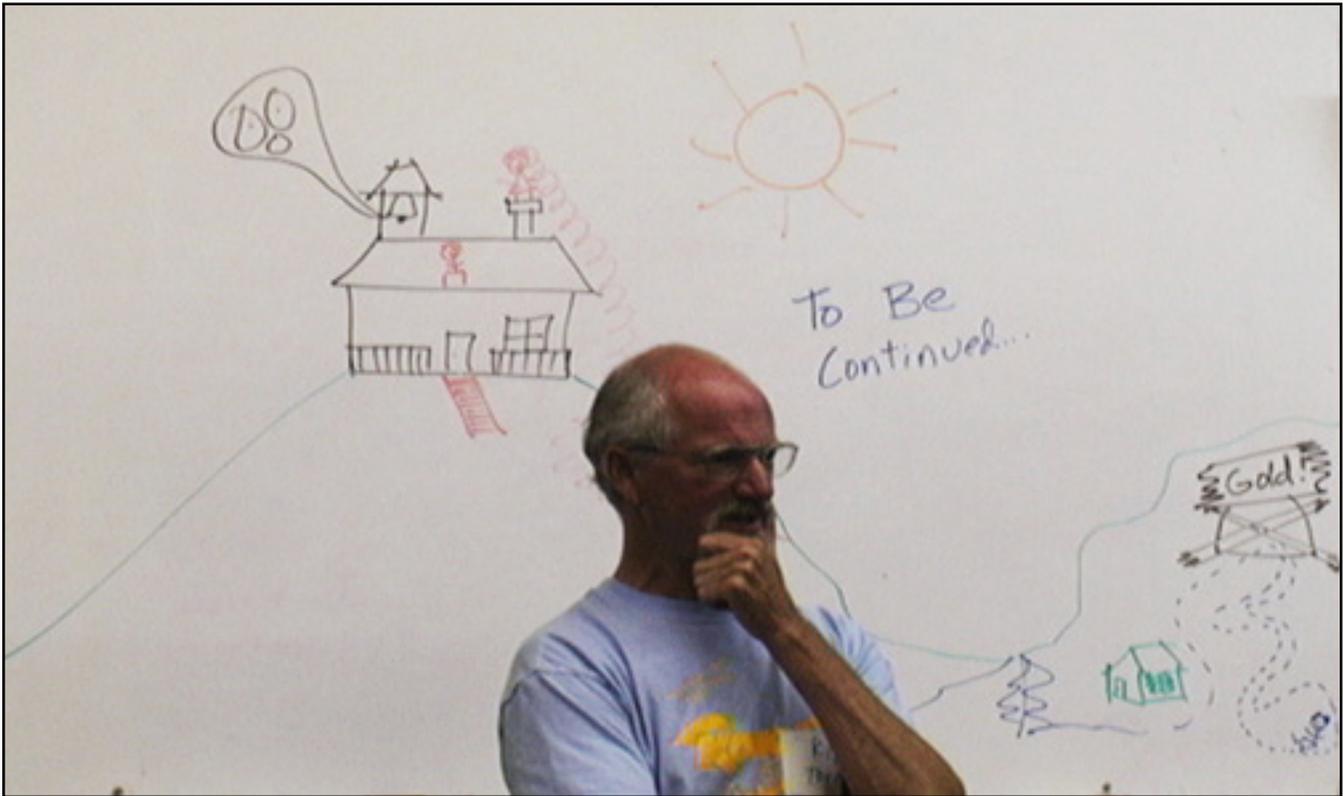


Triangular Prism



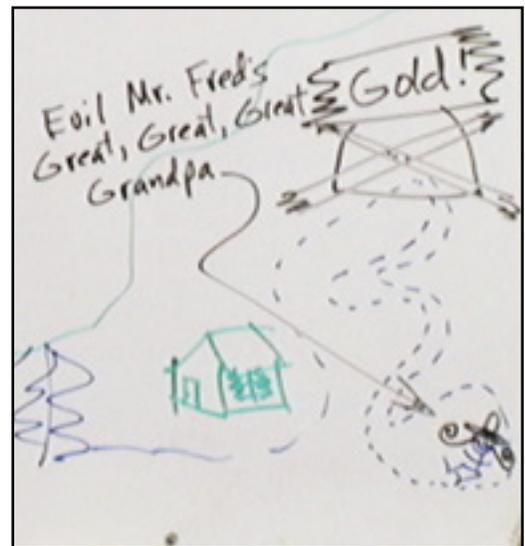
Large Flexible Mirror

Story Recap: "The Ghost in the Gold Mine"



Part 1:

- Jack and Jill bought a haunted house near a deserted gold mine so they could see a ghost.
- The first night, they heard a ghost come clunking up the stairs, but they couldn't see it. The footsteps went through the living room, into the kitchen, opened a cupboard, a cookie floated out, and a bite was taken out of the cookie.
- Jack and Jill ran and hid in their bedroom, but the ghost followed them, so they hit it with their pillows.
- The ghost told them to stop, he didn't like it.
- Jack poured water on the ghost so he could see it.
- Then the ghost went downstairs, sat on the sofa, and read the newspaper until 4 am, then walked out the front door and disappeared.
- Jack and Jill's Grandma lives near the mine. They told her they wanted to get rid of the ghost because it woke them up every night.
- Grandma said they needed to follow the ghost to find out where it lives. Then they could make the ghost go away by sprinkling pepper on his head.

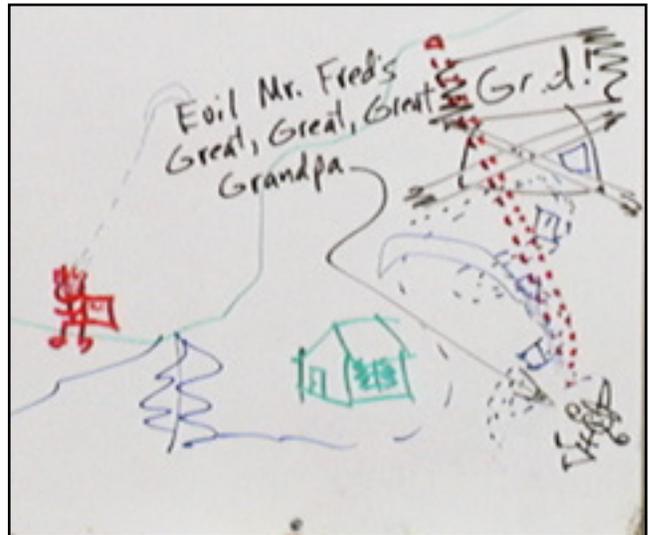


Story Quick Recap (cont.)

- Jack and Jill followed the ghost and found out that he lived way down deep in the old mine. They sprinkled pepper on his head, but it didn't work.
- Then Grandma told them to sprinkle salt on the ghost instead. They tried that, but it didn't work either.
- Then Grandma told them they had to make the noonday sun shine onto the ghost, and then he would go away and never come back.
- But the ghost was deep underground.
- The gold mine is owned by Evil Mister Fred, and the ghost is Evil Mister Fred's great-great-great-grandpa, so he has a hat and a mustache.

Ending:

- Jack and Jill got a gopher to dig a hole down through the mountain, but the hole didn't end up in the right place, so the sun didn't shine perfectly through it.
- They called the Acme Store of Everything and ordered a bunch of mirrors.
- They bounced light from mirror to mirror and hit the ghost, and it faded away. All that was left was his mustache.



Transcript: (No Introduction -- Lesson begins with the story)

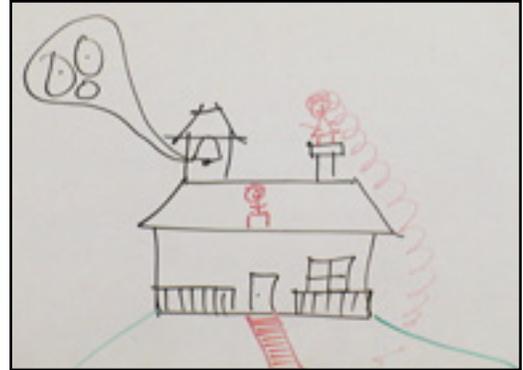
Story: "The Ghost in the Gold Mine"

Once upon a time, there was a haunted house. The haunted house had a railing so you didn't fall off the deck and become another ghost. It had a front door, and a window, and it had walls, and it had a roof, and it had a bell tower, and it had a chimney, and it had a bell in the bell tower with a dinger, and it had a ghost. The house wasn't floating in midair. The house was sitting on top of a haunted hill. And there was a valley, there's a forest, and over in the distance there was a gold mine. It was an old gold mine, but it was all broken down. You didn't want to go in there because the walls were all crumbling, and it had caved in in some places. So there were boards across the front with some nails in them. And there were stories about that gold mine. They said there were people in there, and the roof caved in and killed some of the people. And the ghosts of the dead people still wandered through the gold mine.

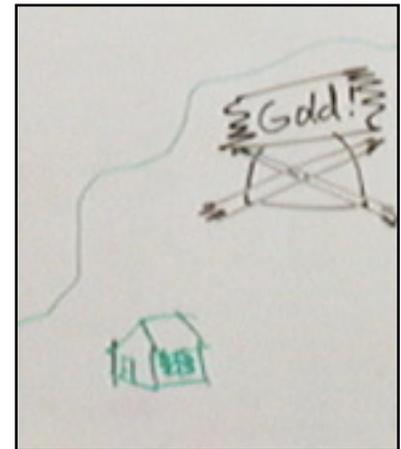
And this big old haunted house was for sale. Nobody wanted to live there. But Jack and Jill heard about it and they said, "Wow! A haunted house. I always wanted to live in a haunted house." So they bought it. Here's Jack. And here's Jill. She's standing on the chimney. And they said, "I hope there's a real ghost there because we spent all this money for this house, and we want to see a ghost."

So they stayed there the first night. And it got to be midnight -- dong, dong, dong -- and the bells were ringing. And Jack and Jill said, "I don't see any ghosts. Do you see any ghosts? There's no ghosts here." And then they heard footsteps. Something was going clonk, clonk, clonk, clonk, clonk, up the front stairs. And they looked out their window and they didn't see anybody there. And then they heard the door open -- screeeeeek! The door didn't really open. It just sounded like it was opening. And then they heard footsteps right across their front living room. And the footsteps went right into the kitchen, opened the cupboard, then they saw a cookie float out and -- gunk -- a bite was taken out of the cookie. Then the cookie was set on the countertop. And their cat was behind the stove, and the cat went "Mreowwww!!" and ran away. And Jack and Jill said, "Whoa, that must really be a ghost."

So they ran upstairs and hid in their bedroom. And they heard the ghost coming up the stairs to the bedroom -- kadunk, kadunk, kadunk, kadunk. Then their doorknob turned -- screeeeeek -- and the door opened. And both Jack and Jill took their pillows and wham! -- they hit the air where the door was. There was a ghost. They went bang, bang, bang -- and they hit the ghost. The ghost said, "Stop! Stop! Quit hitting me! Don't do that! That hurts!" Jack and Jill said, "What? You're not a tough ghost?" He said, "No, I don't like to be hit by pillows. Cut it out!" Jack and Jill said, "Oh." And Jack went and grabbed a big cup of water and poured it over the ghost's head. And the water went all over the ghost.



Jack & Jill's Haunted House.



Grandma's House near the Gold Mine.

Now he's a wet ghost. And he got just disgusted and said, "I've had enough of this. I'm going downstairs." He went downstairs, sat on the sofa, and read the newspaper. And then, about four o'clock in the morning, he wandered back out the front door and disappeared. Jack and Jill said, "Whoa, what a funny ghost."

And they told their Grandma that night about that ghost. And Grandma lives down here by the gold mine. They said, "Grandma, we have a ghost in our house. It's a really cool ghost, but he's not very strong. He doesn't like to be hit by pillows. And he really hates it when we throw water on him. And we thought it would be fun to have a ghost in the house. But night after night, he wakes us up and we can't get any sleep. Do you know how to make that ghost go away?"

And Grandma said, "Well, yeah. Don't you guys know how to make a ghost go away? Everybody should know how to make a ghost go away. Don't they teach you that in school?" And Jack and Jill said, "No. They didn't teach us that in school." And Grandma says, "Why, there's only one way to make a ghost go away. You go find him where he hides at night. When he leaves your house, you follow him, and go see where he is. And you shake some brand new pepper on his head -- shake, shake, shake, shake, shake. And that ghost will just go poof! And he'll never bother you again." Jack and Jill said, "Well, that sounds pretty easy. We could do that."

So the next night, the ghost came and did the same thing as before. And then he went out of the house, down the stairs, down the hill, over the river, through the woods, past Grandma's house, and into the gold mine. Jack and Jill said, "Ooooh, gold mine -- middle of the night. It could collapse. We could die." But they got their pepper, and they were going to go on with it. So they followed the ghost, down deep, deep, deep into the gold mine. And the ghost came clear to the bottom where there was a big chamber, and it sat on the ground -- there's the ghost sitting on the ground. And the ghost sat there and twiddled his thumbs. And Jack came up and said, "Hi, ghost!" and put pepper all over him. And the ghost sneezed, "Ah-choo! Stop that!" And nothing happened to the ghost. Jack and Jill said, "Aww, that Grandma tricked us."

So they went back home and went to sleep. Next day, they said, "Grandma, that didn't work. We put pepper on the ghost, and the ghost didn't go away." Grandma said, "Ohh, I must have gotten mixed up. Let me check my book." So Grandma looked in her book, and she said, "Ah, silly me! You're not supposed to put pepper on the ghost's head. You're supposed to put salt on the ghost's head." And Jack and Jill said, "Oh, boy, this better work. We're really getting tired."



The Ghost in a chamber deep inside the Gold Mine.

So the next day, same thing. They followed the ghost over the river, through the woods, past Grandma's house, into the gold mine, clear to the bottom, and they put salt on the ghost. And the ghost said, "What are you doing that for? I don't like salt. Don't put that on me." And Jack and Jill said, "Aw, that Grandma. She did it to us again." Of course, they went back to Grandma, and said, "Grandma, you've been tricking us. There's no way that that's going to work with this ghost." Grandma said, "Well, I just wanted to see if you would actually pull it off. But here's the real way to do it. All you have to do is

make sunlight -- when the sun is at its highest point in the sky, right at noon, sun is straight up in the sky like that -- make that sunlight land on the ghost. And the ghost will never come again." And Jack and Jill said, "Okay, that's going to be tough. The ghost is in a deep hole in the ground. Hmm." Now if you're Jack and Jill, and you wanted to get rid of that ghost, what would you do?

[Student: Is Evil Mister Fred in this story?] No, he wasn't in this story. This story was invented before Evil Mister Fred was invented, because I've been telling stories for a long time. We could probably stick him somewhere in the ending. What if Evil Mister Fred owns the mine? And what if the ghost is Evil Mister Fred's Great-great-great-Grandpa? We could do that. We'd have to put a mustache on him. We'll put a mustache on the ghost guy. And we'll put a hat on him. There. There's Evil Mister Fred's Great-great-great-Grandpa.



The Ghost is actually Evil Mister Fred's Great-great-great-Grandpa.

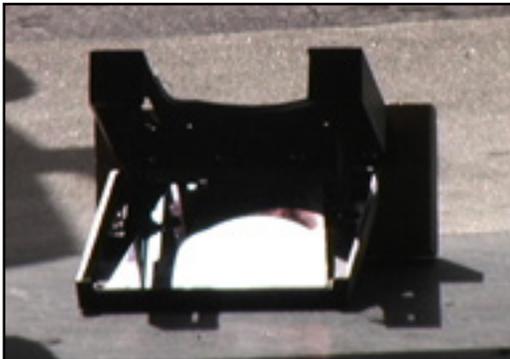
Imagination and Brainstorming Time

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

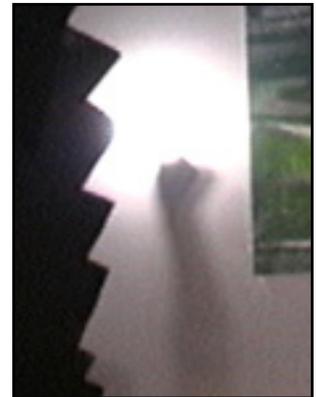
We'll leave this To Be Continued . . .

Demos: Mirrors and Rainbows

We're going to do some experiments with lasers and mirrors, and we need some sunlight for our experiment. We're going to put a mirror outside and see if we can get some light to shine inside. [Shines a spot of reflected sunlight onto inside wall of classroom.] We're going to use the sunlight. You see where the dot is? Memorize that spot. We want to see if the dot is still there in about twenty minutes from now.



Tilttable Mirror reflects sunlight from the doorway onto the wall of the classroom.



Sunlight reflected onto classroom wall.

When I was your age, we could go to Santa Cruz, and there was a Fun House there. Inside the Fun House, there was a big wooden disk, a big circle, about as big as this table, but round. And it could spin. And there was a teenager there with a knob that he could turn to make the table spin faster or slower. And he'd say, "Okay, everybody on!" And we'd all jump on this big table. And he'd say, "Ready? Here we go!"

He'd turn it on and the table'd start spinning really slow. And then it would go faster, and faster, and faster, and faster, until all the kids would go badoomp! and fall off. And there was a bridge from one place to another made out of ropes. And the bridge would go up and down, and back and forth, and shake this way and that way, and they'd knock you off the bridge. And the best part of it was a whole bunch of weird mirrors called Fun House mirrors. They're kind of like this stuff. Now, you can see yourself in this mirror, right? You can tell that's pretty much a regular mirror. Now, if I wanted to make you, say, tall and skinny, I can bend this mirror. Should I bend it outwards or inwards? How many vote for outwards? How many vote for inwards? Okay, it's about even, so I'm going to do outwards first. Are you tall and skinny? *[Students: No.]* Is this a minion-maker? Okay, that was outwards.



Flexible Mirror can be bent to distort the image.

Now we're going to go inwards. Now are you tall and skinny? *[Student: It's upside-down.]* Are you upside-down and tall and skinny? *[Students: No.]* Well, let's try it longways. I'm going to pooch it outwards. *[Student: We look so skinny!]* Now I'm going to pooch it inwards a little bit. Are you the same as before? So we can change how you look with a mirror. Now, suppose you owned a store where you sold expensive dresses to old ladies. And you could put any mirrors you want around the store. Would you put mirrors like this for the old ladies? *[Students: No.]* Would you put mirrors like that for them? *[Students: No.]* Would you do mirrors like this for them? *[Students: No.]* Would you do mirrors like that? *[Students: Yes.]* Yeah. If you want to sell a lot of dresses, you should probably use mirrors like this. And if you go to some stores, you might find the mirrors are slightly bent outwards so the ladies look skinnier in their expensive dresses. Pretty clever, huh? Yeah, then when they get home they say, "What happened? I gained twenty pounds since I left the store."

There's other ways to make things look weird. You can make things look really beautiful or really handsome with this *[holds a fresnel lens]*. If I put it in front of my face, I'll become extremely handsome. You'll say, "Whoa, a movie star in the place! Wow, that is so cool!" Here you go -- a movie star *[holds lens in front of his face, making it look very large and distorted]*. Was my head right side up? *[Students: Yes.]* Okay, and to make my head upside-down, should I turn the mirror upside-down? Should I turn it this way? No? How about if I go like that? *[Holds lens at arm's length in front of face.]* Am I right side up or upside-down? We need the other one to go upside-down. *[Tries using two lenses at once.]* Is that one upside-down? *[Tries a different lens.]* Oh, that one is an upside-down one. Am I upside-down now? *[Students: Yes.]* You guys are upside-down. So we can distort you with mirrors, we can distort you with lenses, there are all kinds of ways to make people look very strange.



Upside-down with a Fresnel Lens.

And we're going to do some experiments with some mirrors. We have mirrors like these *[holds up a 6-inch square mirror]*. They're plastic, so don't rub them on each other too much or they'll just get scratched. They're slightly bendable. And we're going to give each of you two mirrors, and you're going to do some experiments with them and see what happens.

Since our sun is still here, is our sun still in the same spot that it was before? *[Students: No.]* Okay, we've got some sun shining on our wall. It's moved. How did the sun move? *[Students offer explanations.]* Yeah, the Earth orbits around the Sun. And the Earth spins on its own axis. And as the Earth turns, the Sun moves on our wall. I'm going to turn off the lights, and I'm going to put stuff in that sunlight. We'll put a cube in there. We want to see if we find any rainbows. We'll put a cylinder in there and see if that makes any rainbows. We'll put a ball in there and see if that makes any rainbows. We'll put a crystal in there and see if that makes any rainbows. And we'll put a prism in there -- there's a triangular prism here -- and see if that makes any rainbows.

Okay, here's the cylinder in the sunlight. Can you see any rainbow colors? How about if I do it end-wise? Do you see any rainbows that way? *[Students: No.]* So we're rainbowless, right? Okay. Here's a cube. Any rainbows with a cube? Okay, no rainbows with a cube. Here comes the ball. Any rainbows? It doesn't do anything at all? How about a triangle? *[Students: Yes.]* Ah, there's one there. Okay, that's a triangular prism. We'll try a crystal. *[Students: Yes! Millions!]* Now we have a hologram. This is a hologram called a diffraction grating. *[Students: Yes!]* We're going to get a CD just to see if a CD does anything. Will we get rainbows from a CD? *[Students: Yes.]* We'll find out. *[Students: Yes!]* So, if you have a bunch of CDs in a window at home, you can have rainbows all over your house.



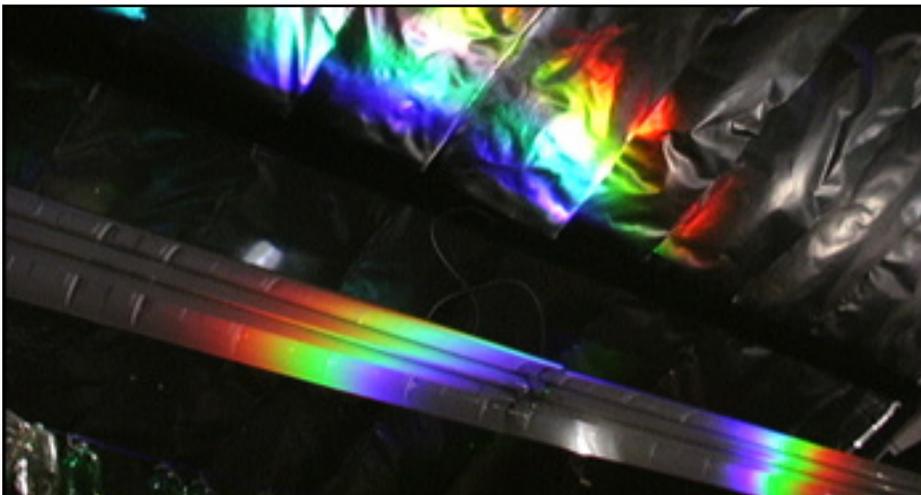
Rainbow from Triangular Prism.



Rainbows from Faceted Crystal.



Rainbow from Diffraction Grating.



Rainbow from a CD.

Experiment: *Lasers and Mirrors*

Okay, we're going to give you two mirrors. And the objective is to give yourself a million eyes, cut off the top of your head, and make a tunnel that looks like it goes all the way through the table top. *[Passes out mirrors, and students experiment with them.]* Try to make everybody else upside-down. Work with one or more neighbors and create a mirror house. Put the shiny sides inwards, then look in through the side.

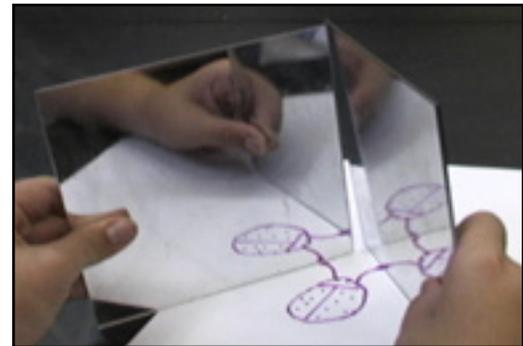


Making other people look upside-down.

[Passes out a sheet of paper to each student and provides colored markers.] When you get a piece of paper, you're going to draw a bug. You can draw one bug, and then you're going to use your mirrors and try to make five bugs.

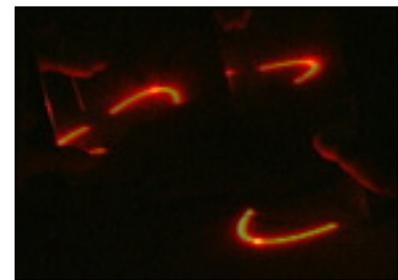


Building a mirror house.



Multiplying a Bug.

Now we're going to blind your bugs with a laser while you hold your mirrors up. *[Turns off lights, then shines a laser pointer into each student's pair of mirrors, making patterns of light as the student slowly opens and closes the mirrors.]*

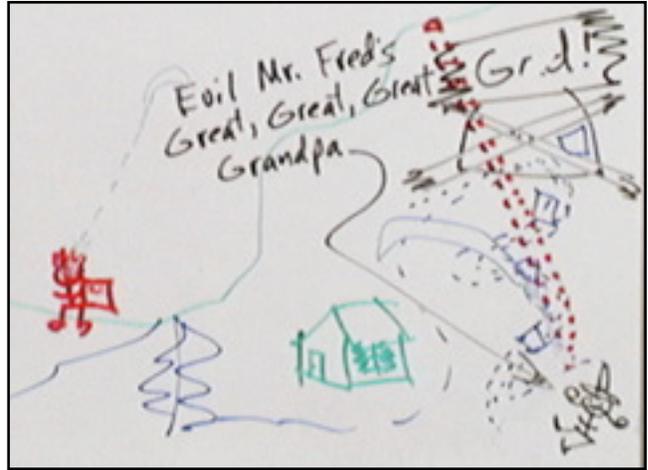


Laser patterns.

End of Story

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

Jack and Jill are trying to get rid of the ghost at the bottom of the mine. Grandma told them to try pepper, she told them to try salt, didn't work. Then she said, "You have to drill a hole in there and make the sun shine right on the ghost." So they got a gopher, and the gopher dug a hole through the mountain, but the hole didn't end up in the right place. And the sunlight didn't shine perfectly through it, and it didn't hit the ghost. And they said, "Oh, no. Too bad." So they called the Acme Store of Everything and they ordered a bunch of mirrors. And they bounced the light from mirror to mirror -- boing, boing, boing, boing, boing, boing -- and hit the ghost. And the ghost started to fade away. "Nooo, pleeease, aaaaaahhhh!" He got dimmer, and dimmer, and dimmer, until just his mustache fell off. And that was the end of the ghost.



End of Lesson

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