



Teacher's Guide for:
Pinhole Masks

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.

Contents:

Quick Reference Sheets:

- Intro: page 2
- Experiment: *Pinhole Masks* page 3
- Equipment List: *Pinhole Masks* page 3
- Story, Part 1: *Jack and Jill and the Space-Time Warp* page 4
- Story, Ending. page 5

Video Transcript:

- Intro: page 6
- Story, Part 1 : *Jack and Jill and the Space-Time Warp* page 8
- Experiment: *Pinhole Masks* page 10
- Story Ending page 12

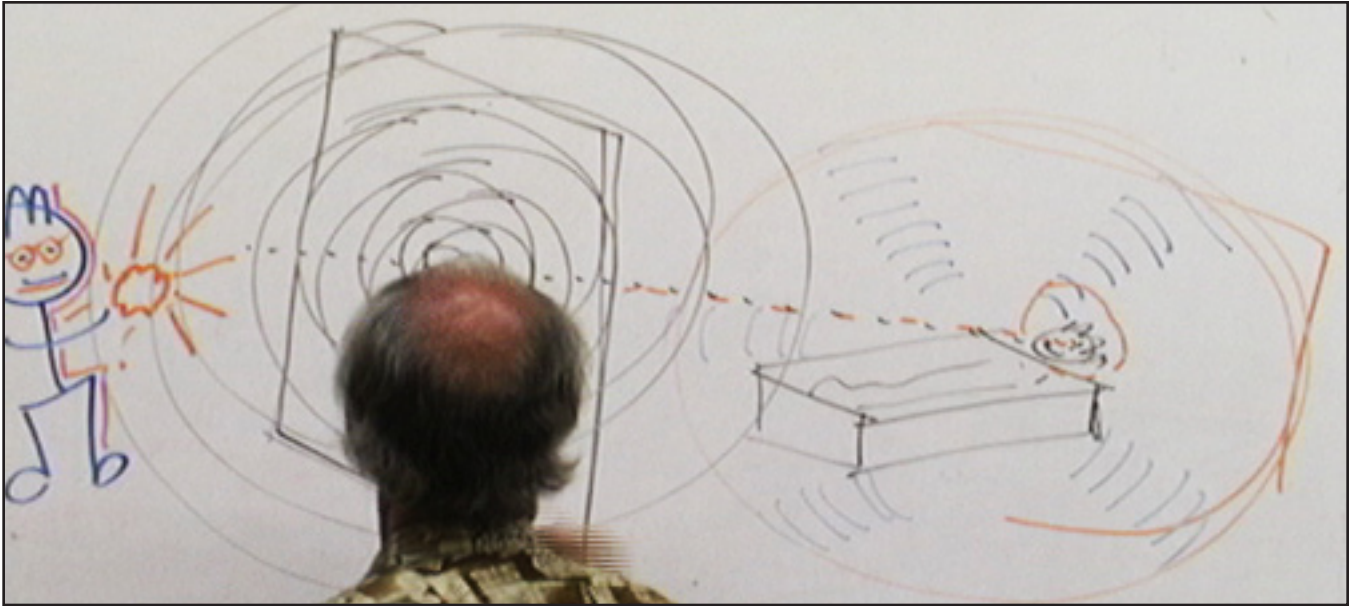
Title Page of Video

Pinhole Masks
A Rock-it Science Lesson
Filmed November, 2010

Rock-it Science
2110 Walsh Ave, Unit F
Santa Clara, CA 95050
www.rockitscience.org

(c) 2012 Rock-it Science Educationally Useful Programs. All Rights Reserved

Intro Quick Recap:



- Suppose a piece of the sun falls off and lands in your back yard, and it's really bright.
- Your neighbor wants to sleep, so he pulls down his curtain. There's a hole in the curtain. Will he be able to sleep? Why not?
- The sunlight shines straight into his eyes.
- So he pokes another hole in the curtain. Will he be able to sleep now? No, now it's even worse.
- If you poke one hole, it doesn't make a circle of light on the wall; it lights up the whole room.
- If you poke two holes, it starts making patterns on the walls, with dark and light spots.
- This is because sometimes light acts like little bullets, and sometimes it acts like waves.
- When it goes through a hole, it acts like a wave that spreads out like ripples on a pond. When it shines through the second hole, the ripples are centered on that hole, and it gets to be a confusing mess, with light and dark bars.

Experiment Quick Recap: "Pinhole Masks"

- Students make an eye patch from adhesive-backed black plastic and poke a pinhole in it.
- They put it on, close the other eye, and look through it. Then they poke a second hole and look through it.
- Then they poke four holes, then eight, then as many as they want.
- Then they make a mask out of mirror mylar and use only a pinholes for each eyehole.
- They decorate the mask with permanent markers, use a paper punch to make a hole on each side, and tie a long thin balloon through the holes to hold the mask on.



Eye Patch



Mirror Mask

Equipment List: "Pinhole Masks"

Items needed for Instructor:

Consumables:

- (same as students)

Other:

- Pizza wheel
- Hard mat (to put under pizza cutter)
- Hole Punch

Items needed for Students:

Consumables (per student):

- Plastic, flexible, black, self-adhesive, 3" x 3"
- Mirror mylar, approx. 8" x 10"
- Balloon, long thin

Other (per student):

- Pushpin
- Cardboard, approx. 4" x 6" to put underneath when poking holes
- Markers, permanent
- Scissors

Prep Work:

- Cut plastic into 3" x 3" squares
- Cut mylar into 8" x 10" pieces
- Cut scrap cardboard into 4" x 6" pieces
- *[Note: In this class, the Instructor cut the plastic and mylar pieces during the lesson with a pizza wheel, but this can also be done ahead of time.]*

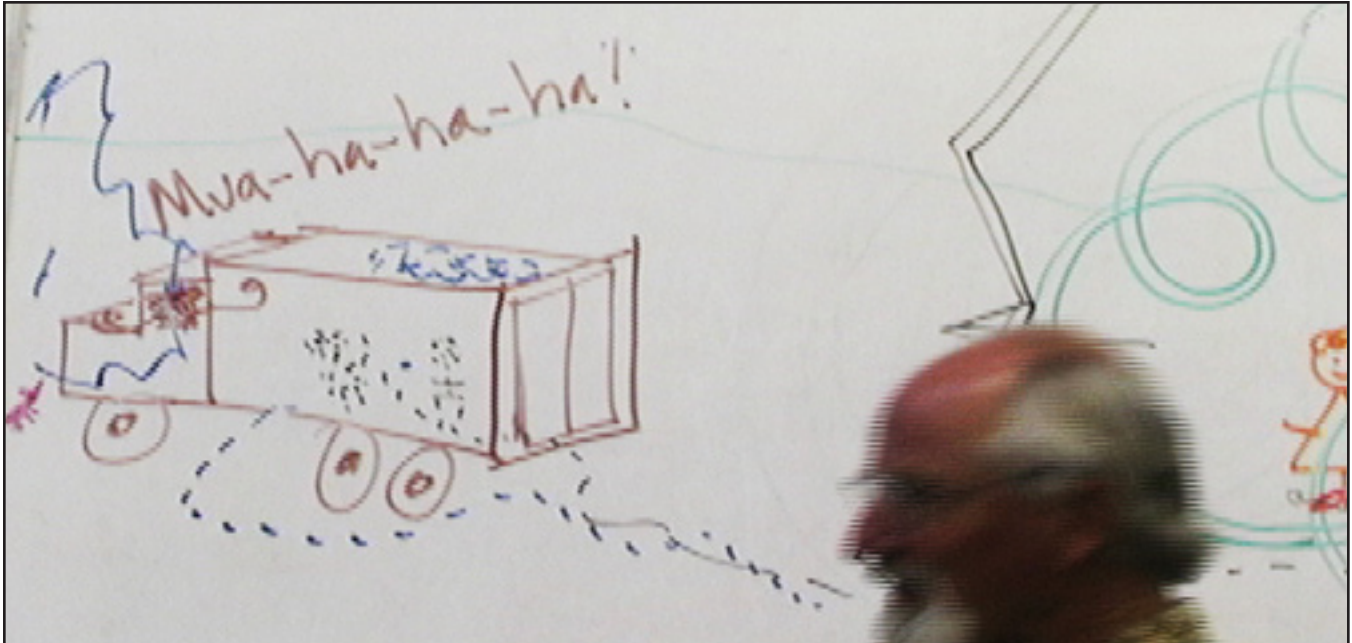
Story Recap: "Jack and Jill and the Space-Time Warp"



Part 1:

- Jack and Jill found a weird toadstool that talked. It asked Jack and Jill to take it to an amusement park to ride a roller coaster.
- When Jill touched the toadstool, her shoes turned to ruby slippers. She clicked her heels, and they were suddenly at an amusement park.
- There was only one ride -- a roller coaster called the Barf Express.
- Jack and Jill didn't notice that there were minion footprints on the ground, and that the toadstool had a tiny mustache, and the roller coaster had a mustache.
- As the roller coaster went faster and faster, they got dizzy. Then everything started going in slow motion, and they broke out into another dimension.
- They found themselves trapped in the back of a truck being driven by Evil Mister Fred.
- Wherever they go, they leave a trail of Jill hair, even through the warp in the space-time continuum.

Story Recap (cont.):



Ending:

- Evil Mister Fred is driving on the other side of the road because everything is backwards. He has to steer backwards, and he uses the brake to go faster, and hits the gas pedal to stop.
- There's a gopher in the road, and Evil Mister Fred is trying to hit it with the truck.
- Jack finds a nail and punches a hole through the side of the truck.
- Now all the scenery they're passing is projected on the opposite side of the interior of the truck. Jack accidentally made a pinhole camera.
- As Evil Mister Fred tries to steer toward the gopher, he steers the wrong way and hits a tree. The truck flips in the air.
- Jack and Jill notice a trap door in the floor. To get it open, they have to try to close it by jumping up and down on it.
- When they get out, they start running backwards toward the warp. The slower they move, the faster they go.
- In order to go through, Jill has to say she does NOT want to go through. Then she clicks her heels and goes through.
- Jack doesn't have ruby slippers, so he says he doesn't want to go through and hits himself in the forehead. Then he goes through.
- The warp starts to seal itself up just as Evil Mister is trying to get out.

Transcript: Intro

Suppose you're out walking in your yard one day, and you notice a piece of the sun had fallen off and landed in your back yard. So you pick it up. There's a piece of the sun. Would it burn you?

He's got glasses made out of the sun. There. And it's really bright. And your neighbor doesn't like it. He's trying to sleep, and there you are, fooling around with a piece of the sun. So he pulls down his curtains. And he's got this big old curtain in his back yard. Looks like a door, doesn't it? And the curtain has a hole in it. And he's trying to sleep. And you keep moving around. And he's here, trying to sleep. Is he going to be able to sleep with you moving around out there? *[Students: No.]* Why? *[Student: Because there's a hole in the curtain.]* Yeah.

The sunlight shines through right on his eyes. So he says, "I'll fix that!" And he gets up and he pokes another hole in the curtain. And will he be able to sleep now? *[Students: No. Yes. No, it'll be even worse.]* Even worse.

Well, scientists tried this trick here. If you poke one hole through, it doesn't do what I thought it would do, anyway. I



One hole lights up the whole place.

thought it would make a circle of light on the wall. Say this is the wall behind him. I thought it would make like a circle of light on the wall. But if you poke a hole and let sunlight shine through, it doesn't do that. It lights up the whole place.

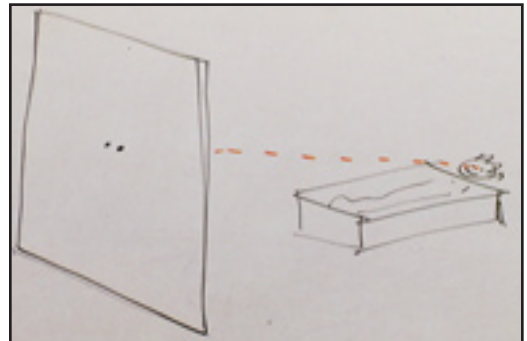
You can try that. You go home and say, "Mom, Dad! I need to poke a hole

in the wall." Okay, here's a gun. Pow! Okay, now we've got a hole in the wall. And when the sun shines through, it lights up the whole place, which is really weird.

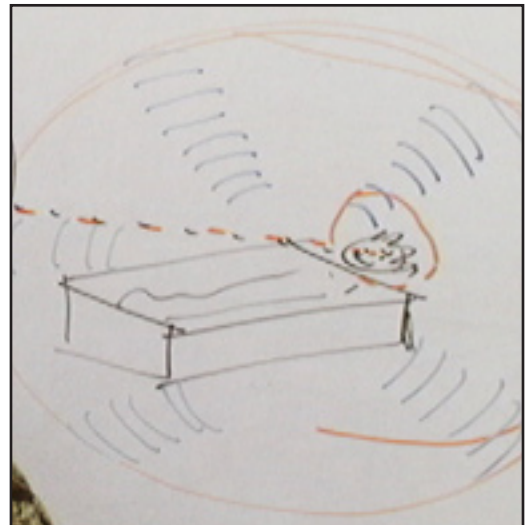
And if you poke two holes in the wall, something even more bizarre happens. It starts making patterns on the walls, with dark and light spots. And the scientists said, "This is not right. Somebody call Einstein. This can't happen."



A piece of the sun and a hole in the curtain.



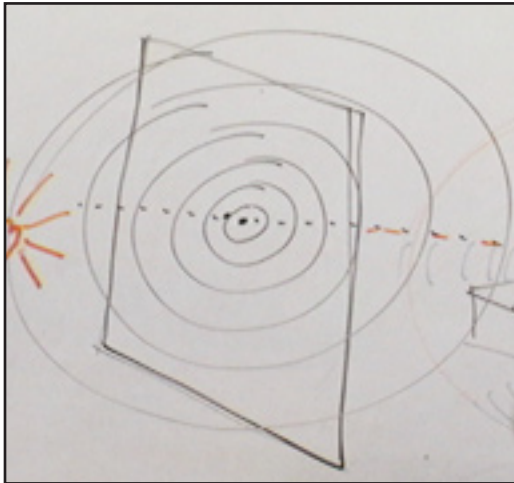
With two holes, neighbor still can't sleep.



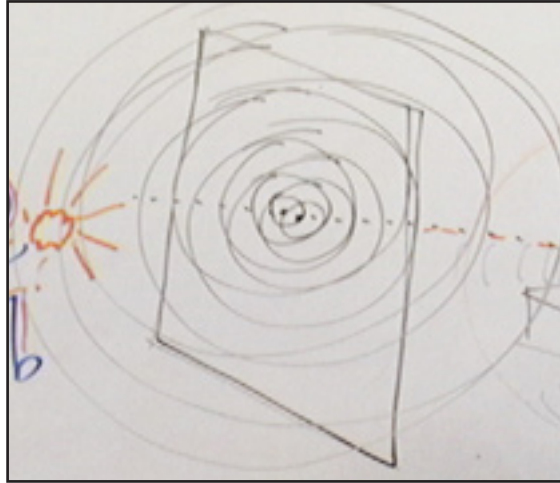
Two holes make dark and light patterns.

And some scientists, before they discovered this whole thing here, they said light always acts like little bullets. If it was like little bullets, you know, they'd go right through and drill a hole in the guy's head. But it doesn't. It sometimes acts like waves. And when it goes through the little hole, it acts like a wave that spreads out like drip-dropping a pebble in a pond. And these waves from one hole would look like that.

From the second hole, they would be centered on that hole. And it gets to be a confusing mess. But the pattern that ends up looks like this, with bars of light and dark. So the whole business of letting light go through a little tiny hole is what we're going to be exploring today. And we're going to do something goofy while we do that as well.



Light from one hole ripples out in waves.



Ripples from two holes overlap, creating patterns.

Story: "Jack and Jill and the Space-Time Warp"

Once upon a time, Jack and Jill were wandering out in the woods, and Jill found a toadstool. Or a mushroom, maybe. But it was a weird-looking one. It was all red, and it had big white spots on it. We need a horizon. Since they're out in the woods, we need a green horizon. The mushroom with spots.

And Jill said, "Whoa, look at that mushroom! It's got spots!" And Jack said, "Big deal." And Jack bent down to pick it, and the mushroom said, "Please don't pick me!" And Jack said, "What? A talking mushroom!" And Jill said, "Wow! I like that mushroom. What can I do for you, mushroom?" The mushroom said, "Well, let's see, I would like to go to an amusement park and ride a roller coaster." And Jill said, "Well, that's kind of hard to do. You're stuck in the ground." And the toadstool said, "Well, okay, I'll let you touch me." And Jill said, "Uh, what's up with that?" And so she touched it. And all of a sudden her shoes turned into ruby slippers. And Jack said, "I've seen that before! Ruby slippers. I know what you do with those. You click your heels three times, you go in circles, and you swing a chicken over your head or something."

And she said, "No, no, no, no, no, no chickens. You're supposed to click your heels and go around in circles and say 'I want to go home,' but we want to go to the amusement park." So she clicked her heels, went in circles, and poof! There they were, in an amusement park. And there was only one ride in the amusement park -- a roller coaster that ruby slippers were allowed on.

There. That's a weird roller coaster. I guess it should have two rails so you don't fall off. How fast should it go? Should it go slow or fast? It's called the Barf Express. And Jill's got to have on the ruby slippers. There.

Well, now, if Jack and Jill have been really smart and had been very observant, they would have noticed by this mushroom there were faint prints on the ground -- minion footprints. And they might have noticed that the mushroom had a tiny little mustache. And now, Jill's wearing these shoes, and she didn't even bother to look closely to notice that each shoe had a little mustache.

And they took the mushroom for a ride on the roller coaster. And the roller coaster had a mustache. And it went faster and faster and faster and faster, going round and around and around, and their heads were spinning, and they couldn't see anything. And they said, "Oh, no, what's happening?"



Jack & Jill and the toadstool.



The roller coaster.

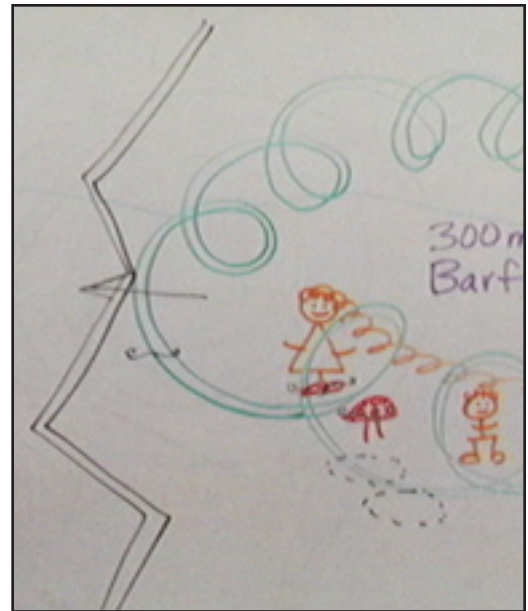


The toadstool had a mustache, and there were minion footprints on the ground.

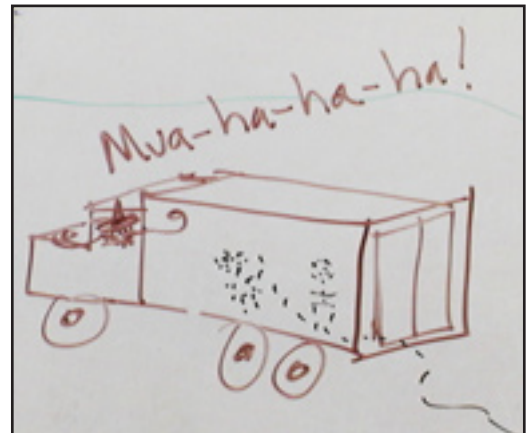
And then everything started to go slower and slower and slower. And they could see their hands moving like this *[moves hands in slow motion]*, very slowly. They were going into another dimension. And in their next dimension -- we need a dimension line -- they broke through the space-time continuum and popped out on the other side.

And on the other side, there was no bright sunshine and flowers and birds singing. It was dark and gloomy and dreary and dripping. And hot, and smelly.

And Jack and Jill felt that they were being transported somewhere in the back of a brown truck, driven by none other than the Evil Mister Fred. And they're prisoners. And he's laughing in the front -- "Mwah-ha-ha-ha!" And Jack and Jill said -- I should draw them in here so you can see that they're in here. And wherever they go, they leave a trail of Jill hair, even through the space-time continuum. There's Jack and Jill inside the truck. Now, if you're Jack and Jill, trapped inside of a truck, on the other side of a warp in the space-time continuum, being driven to who knows what kind of pain and horror by the Evil Mister Fred, what would you do?



A warp in the space-time continuum.



Jack & Jill inside Evil Mister Fred's truck.

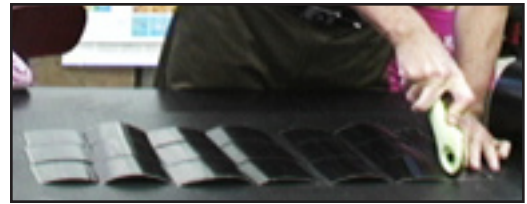
Imagination and Brainstorming Time

[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: "Pinhole Masks"

Well, first we need to make an eye patch. For eye patches we need some black stuff. Here's some black stuff, a big sheet of it. This is sticky-back plastic, and we're going to divide it into [pieces]. [Instructor uses a pizza cutter to slice the plastic into approx. 3" x 2" rectangles.]



Cutting eye patches with a pizza wheel.

[Student: If we wear glasses, do we have to wear an eye patch?] Yes, you've got to wear an eye patch.

Doesn't look like an eye patch, though. It's rectangular. We don't like rectangular.



Cutting corners off an eye patch.

Now some people, if you give them a piece of plastic like this and say, "Make a circle out of it," they cut into the center and they make this itty-bitty little circle, and then they say, "Mr. Mac, it's too small!" If you just chop off the corners, then you'll end up with an eye patch that's nice and big. Yes, you have to use baby scissors. You have to talk baby talk while you're using the baby scissors.

And then you need to poke a hole in it. And it's better to poke a hole when it's not on your eye. So we only want one hole. For some reason, some people, if you give them a pin and a pad and a piece of plastic, they just go "Oh, oh, oh!" -- whack, whack, whack, whack, whack, whack, whack, whack. [Pretends to punch many holes in the plastic with the pin.] And this pad should have like four holes in it. You see how many holes are in that pad? Well, we only want one hole. You can go whacka-whacka later and punch more holes.

And then you try to get the paper stuff off the back. Then you stick it on your eye. [Student: Really?] Well, how else are you going to do this if you don't stick it on your eye? [Instructor puts eye patch on his eye.] There. Then you look through the hole and see what you see. And if you see anything, that's good. If you don't see anything, that's not so good.

Okay, so everybody's going to make an eye patch, make one hole, and look through it. [Student: Can we keep our glasses on?] It's hard to look through the hole with glasses on.

[Instructors pass out pieces of plastic, pushpins, and scissors. Students trim the eye patches, punch a hole in them, pull off the backing and put them on their eyes.]

Something good will happen when you look through that hole without your glasses. If you can't get your paper off of yours, hand it to your neighbor who can get the paper off, because it takes a sharp fingernail, and some people have dull fingernails.



Looking through the eye patch.

Once you've got yours on, look at your finger through it. *[Instructor demonstrates by holding finger about a foot in front of his eyes, then moves it closer and further away until he can see it well.]* And even if you wear glasses, you should be able to see your finger perfectly clearly.

Now poke a hole next to that one and see if you see two fingers.

Now, poke four holes in it. Make a total of four -- two new holes.

Now, poke four more holes. Put them really close together, see if that helps.

And after you've tested it, poke one thousand eighty-two holes in there. That's how the pads got all hole-y. Poke as many as you can in there. Now look through it with all the holes in it.

[After students experiment with eye patches for awhile, Instructor brings out sheets of mirror mylar, cuts them into approx. 8" x 10" sections, and passes them out.]

The idea is to make some sort of a mask so people cannot see the expression on your face -- or hear any of your thoughts.

You can cut it into a mask shape, but you're not allowed to cut eye holes. You have to use pin holes instead of scissor-cut eye holes. Then we're going to give you permanent markers and you can draw on them and make it look however you want it to look. We're going to give you a balloon to stick it on with so you can make it stay on your head. When you want a balloon hole, you use a hole punch.

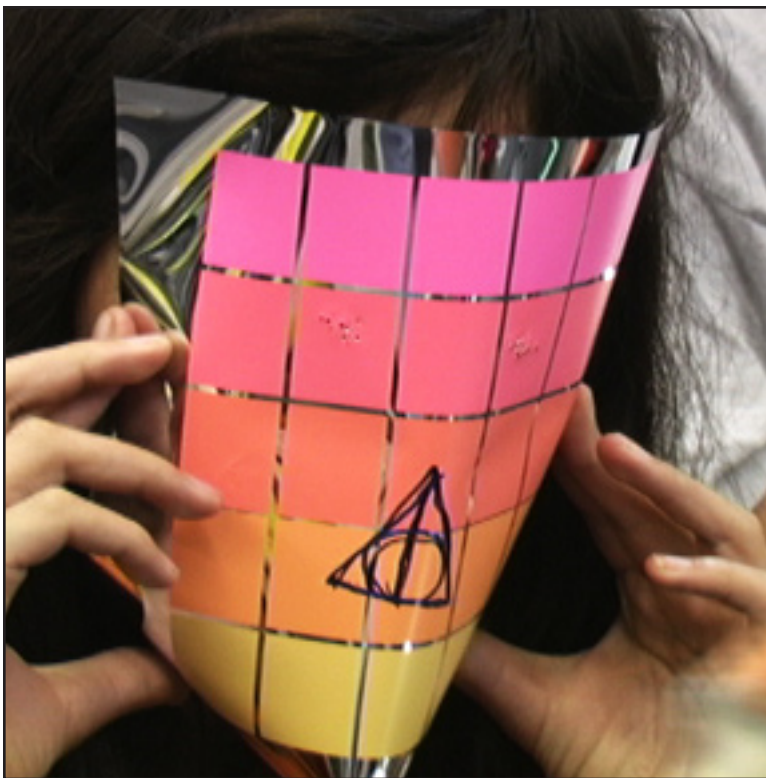
[Students color their masks, punch pin holes in them for eyes, punch a hole on each side and tie a long thin balloon through the holes to hold the mask on.]



Looking at your finger.



A patch with lots of holes.



A mask with multiple eye holes.

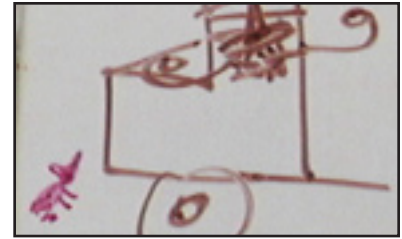


A thin balloon tied on at each side.

End of Story

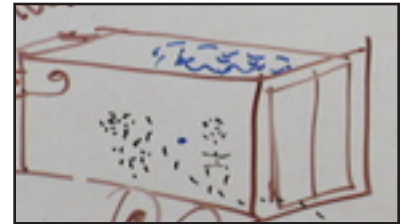
*** DO NOT * present this part of the lesson until after the experiments!**

So Evil Mister Fred is driving on the other side of the road because everything is backwards. If he wants to turn right, he has to steer left. If he wants to stop, he has to push on the gas pedal. If he wants to go fast, he has to push on the brake. But he's getting it figured out. And Jack and Jill are trapped in the back. And Jack is angry because he's trapped. He goes, "Arrrghhh!" and he's jumping up and down, and he's pounding on the walls. *[Student: There should be a shiny purple gopher.]* The shiny purple gopher is sitting in the road. There's a shiny purple gopher. And Evil Mister Fred is trying to hit it with the truck.



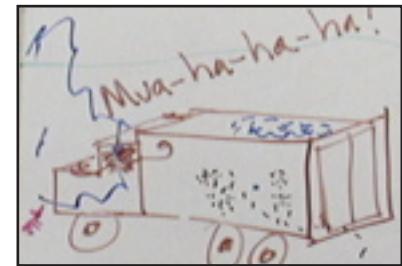
Purple gopher in front of truck.

And Jack found a nail in the back of the truck. And he's trying to poke a hole through the wall. And Jill said, "Jack, what are you doing?" And Jack said, "Arrrghhh!" -- wham! And he poked a hole in the wall. And Jill said, "Whoa, look at that!" On the other wall -- on the wall behind them -- now was a picture of all the scenery as they went by. Jack had accidentally made a pinhole projector. And Jill said, "All right, Jack! We can see where we are." And they could see that they were in this weird place.



Scenery projected inside truck.

Now Evil Mister Fred saw the shiny purple gopher in the road, and he says, "Yeah, gonna kill that gopher!" And he tried to steer to hit it, but he steered the wrong way. And he missed the gopher and ran off the road and hit a tree. So now the whole front of his truck is all smashed in. Jack and Jill hit the back of the truck, the truck flipped up in the air, and they noticed that there was a trap door in the floor. And they tried to open the trap door, but since everything was opposite, when you try to open it, it stays closed. So Jack tried to close the trap door by jumping on it, and when he did -- phew -- he fell right through. And Jill said, "Whoa!" So she jumped on it, too, and went right on through. And Jack and Jill said, "Well, poor Evil Mister Fred."



Truck smashed.

And they started running back, following Jill's hair. They had to run backwards, they had to walk backwards. And the slower they walked, the faster they went. And they got to the space-time continuum warp, and Jack said, "What now? We want to go through." And Jill said, "That's easy. We'll just want to NOT go through." And Jill stood there and she says, "I don't want to go through. I don't want to go through. I refuse to go through." And she clicked her heels together, and poof! Jill popped over onto the other side. And Jack said, "I don't want to go through. I don't want to go through." And he clicked his heels together, and nothing happened. And Jack said, "Doh!" *[hits himself on the forehead]*. As soon as he hit himself, he popped through. And they saw the hole in the space-time continuum start to seal up. And they saw Evil Mister Fred trying to get out himself, but wham! -- it was too late. And they all lived happily ever after, except Evil Mister Fred.

End of Lesson

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