



Teacher's Guide for: **Hovercraft**

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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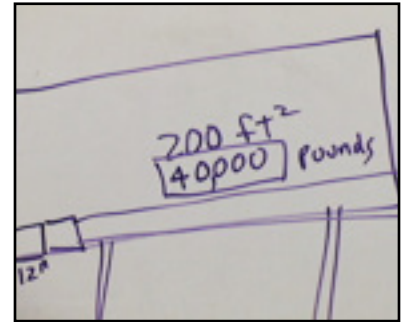
Hovercraft
A Rock-it Science Lesson
Filmed June, 2009

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Intro Quick Recap:

- There used to be lots of billboards along the roadsides.
- Once there was a hurricane, and the wind knocked over the billboards. They started flying through the air and chopped houses in half.
- In order to prevent this from happening again, billboards were required to withstand about forty thousand pounds of force. This number was determined by the square footage of the billboard.
- Air pressure pushing on something can make it tip over or sometimes hover above the ground.
- If you make a strong wind blow downwards with a fan, you could lift up heavy things.



40,000 pounds pushing on the billboard.

Experiment Quick Recap:

Part 1: Balloon Demo

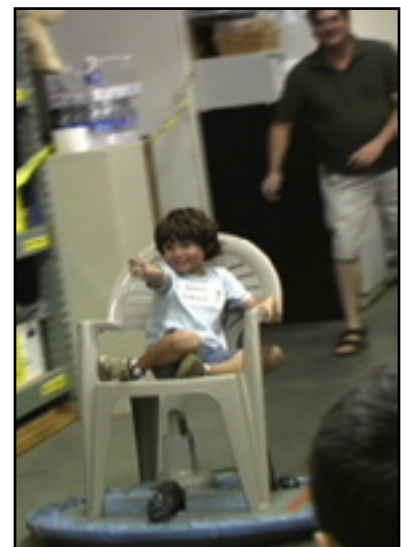
- Take a folded-up folding table and place it on top of the students' table.
- Place six inflated balloons under it, one at each corner at two at the sides.
- Have five students sit on the folding table, adding one student at a time. See whether the pressure of the air in the balloons will hold their weight. The Instructor can also stand on the table with them.
- Afterwards, have the students return to their seats. Then have one of them step on one of the balloons and break it, to show that it's just an ordinary balloon.



Five students on the table.

Part 2: Leaf Blower Hovercraft Demo (optional)

- Build a hovercraft from a plastic chair with arms, a circular wooden platform, and a leaf blower. (Contact Rock-it Science for further info if you're interested in making one.)
- Have an assistant demonstrate by sitting in the chair while the Instructor controls the leaf blower. The platform will just barely hover, and the rider needs to keep their weight centered so the platform won't drag on the ground.
- Then let each student take a turn riding on the hovercraft.



Student on leaf blower hovercraft.

Experiment Quick Recap (cont.):

Part 3: Build a Hovercraft

- Instructor demonstrates how to build the hovercraft, then students each build one.
- Begin with a plastic test tube that has a small hole in the bottom.
- Place an 11" balloon over the rounded end of the tube and secure it with a plastic tie wrap.
- Place the open end of the test tube into the hole in the center of a CD, centering it with a second test tube that has a spring on it. This will keep the test tube vertical so the hovercraft will be balanced.
- Apply hot glue all around the edge of the test tube where it meets the CD. There should be no way for air to escape around the edge of the tube. Keep the centering tube in place until the glue dries completely, then remove it.
- Insert a balloon pump into the test tube and inflate the balloon.
- Remove the pump, place the CD on the table, and give it a little push. It should glide easily over the table.
- Pass out test tubes, balloons, and tie wraps, and have students assemble them.
- Then give them the CDs and centering tubes. Then have them apply the hot glue.
- After the glue dries, have them remove the centering tubes, inflate their balloons, and test their hovercrafts.
- Each balloonful of air will only last about ten seconds, so students will want to inflate their balloons several times, sharing balloon pumps with other students if necessary.
- If the floor is smooth and clean, students can also try using their hovercrafts on the floor.



Balloon, test tubes, tie wrap, & CD.



Use balloon pump to inflate.

Equipment List: "Hovercraft"

Items needed for Instructor:

- Six-foot folding table
- Six 12" balloons
- Adult-size hovercraft made with circular wooden platform, plastic chair, and leaf blower

Items needed for Students:

Consumables (per student):

- Test tube with small hole drilled in bottom
- 12" balloon
- CD
- Plastic tie wrap
- Glue sticks

Other:

- "Test tube centerer" (test tube with spring attached)
- Glue guns
- Balloon pumps
- Permanent Markers

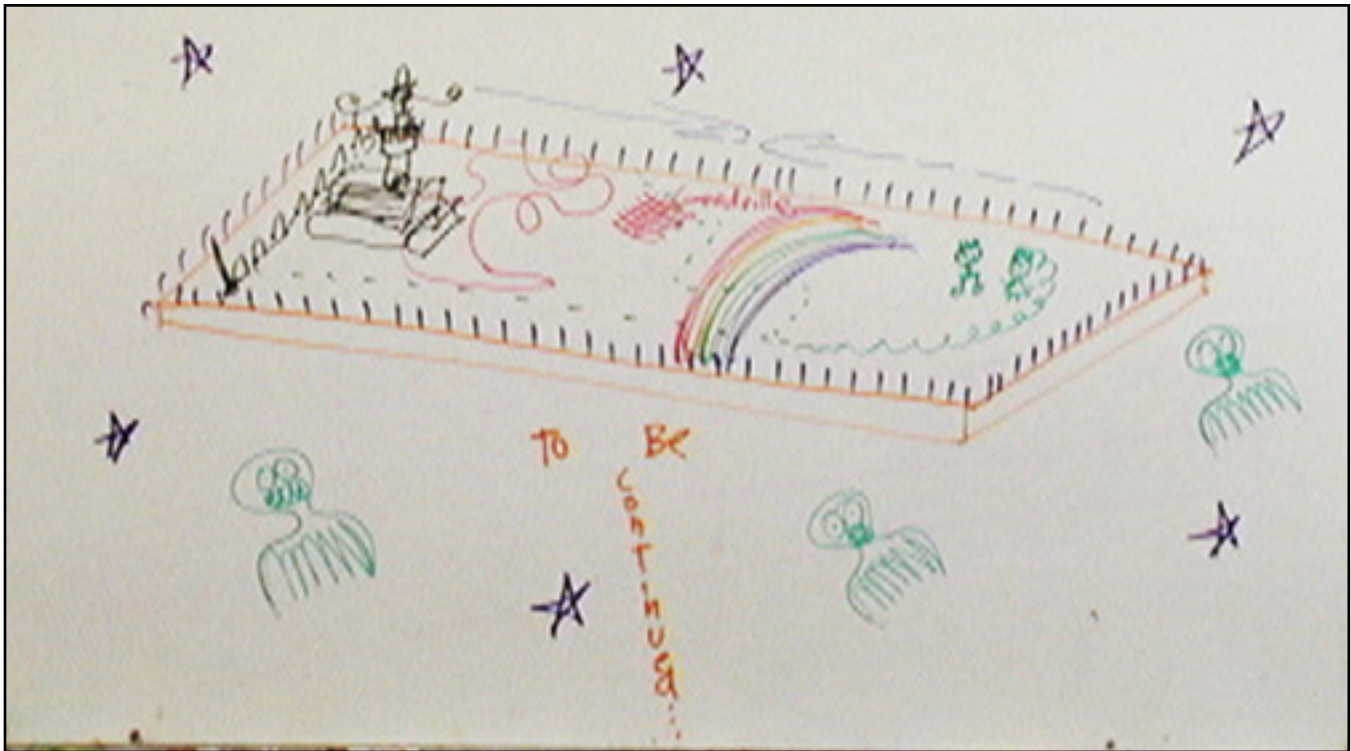
Prep Work:

- Burn a hole in the bottom of each test tube. (See Prep video)
- Attach spring to centering test tubes.
- Build a hovercraft chair (optional)



Test tube with a spring on the bottom.
This holds the other test tube straight
until the glue dries.

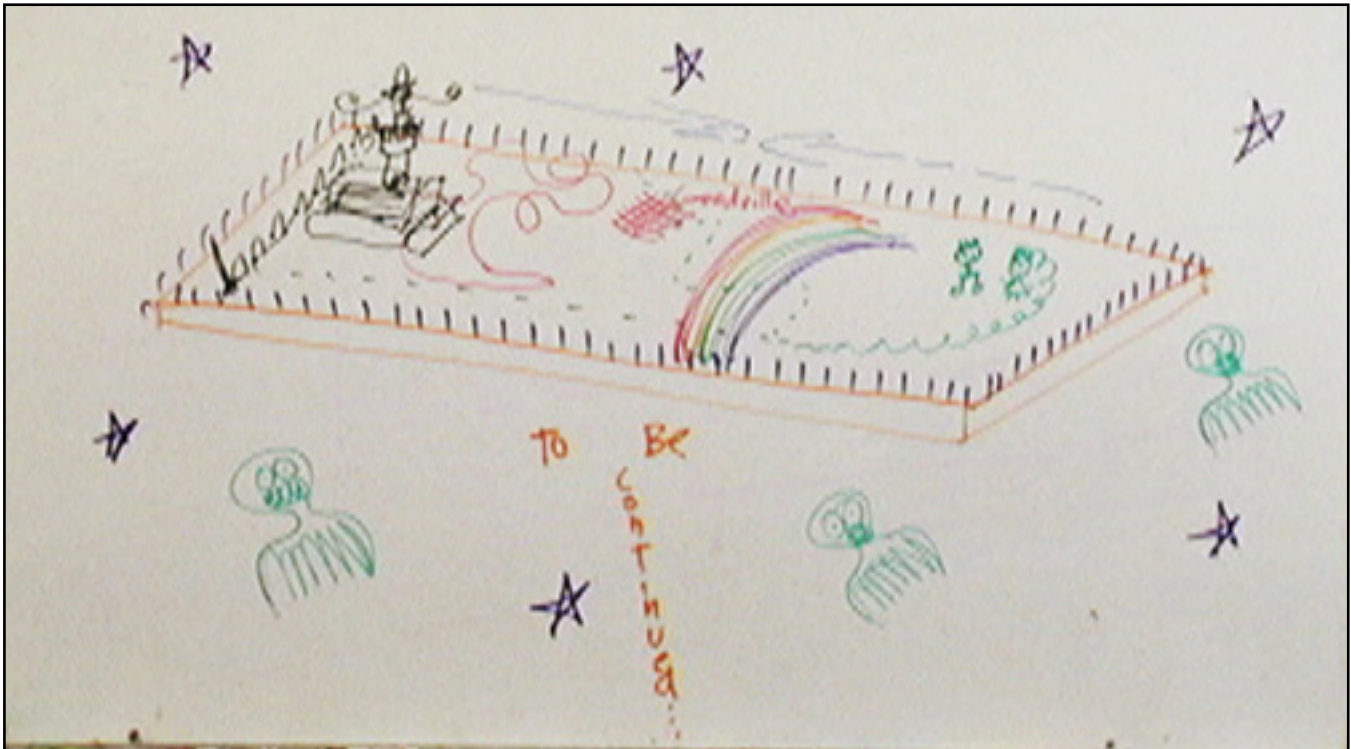
Story Recap: "Jack and Jill and the Octomonsters"



Part 1:

- Jack & Jill are living on a flat planet, floating in space, with man-eating octopuses circling it.
- People would warn their children not to walk near the edge so they won't fall off and be eaten by the octopuses. The mom would throw a sandwich over the edge so the kids could see the octopuses come out from underneath and eat it.
- Evil Mister Fred had a castle on this planet. He made a deal with the octomonsters to get their gold in return for throwing people over the edge.
- Jack and Jill were helping the people of Goodville plan their Olympics with lots of events and fences all around the edge of the planet so no one would fall off.
- One of the events was juggling bowling balls on a roller coaster. This was especially difficult because sometimes the planet would tilt like a teeter-totter, and sometimes the wind would blow in different directions.
- Evil Mister Fred had his minions line up at one end of the planet with their baseball bats, along with Evil Mister Fred in his bulldozer. The minions were going to hit everyone with their baseball bats and drive them to the edge, and Evil Mister Fred would push them off with his bulldozer.

Story Recap (cont.): "Jack and Jill and the Octomonsters"



Ending (same illustration, no additional drawing):

- Jack and Jill realized what Evil Mister Fred was going to do, so they wanted to warn people.
- Jill told Jack to yell really loud, but his voice wasn't loud enough, so no one heard him.
- Jill told him to try again, and when he started to yell, she pulled his underpants so he yelled really loud.
- When people heard Jack yell, they panicked and started running around.
- They ran into the local restaurant and grabbed pancakes. They laid face down on the pancakes, blew a hole through the middle of them, and created so much air under them that they were now hovering around on the pancakes.
- Then the planet started to tilt just as the wind changed direction, and the people on their pancakes started to fall in toward Evil Mister Fred.
- They hit the bulldozer and pushed the bulldozer and minions over the edge. At that moment, the planet tilted back again, so no one else went over.
- The octopus monsters ate Evil Mister Fred and all the minions.

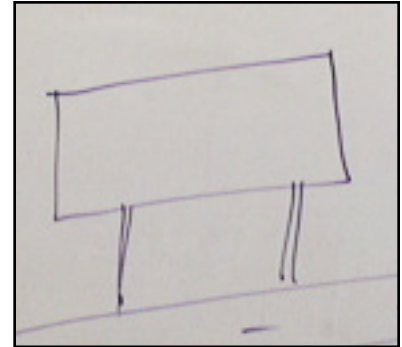
Transcript: Introduction

In the old days, if you went to drive anywhere, along the roads there were cows, and fields, and farms, and something called billboards. They weren't Bob Boards, they were Bill Boards. The billboards were advertisements for eating at restaurants, or going Winchester Mystery House, or anything like that. Huge signs like this, stuck on a couple of poles. And the road would come by like that. There wasn't just one billboard, there were thousands of billboards. Every you went there were billboards. There were so many billboards, they had to make a law that says, "You don't get to put anymore billboards up." You couldn't even see the trees and the farms because there were billboards everywhere.

One time there was a big windstorm, a hurricane came along. And a bunch of the billboards fell over. And they started flying through the air. Big huge rectangles of flying steel, and they chopped houses right in half. And they said, "We've got to do something to make sure these billboards don't fall over and kill people." And they made some rules.

They said, "Count how many square feet there are on your billboard." A square foot was twelve inches by twelve inches. "And then multiply that times about two hundred." Really one hundred forty-four. "And then multiply that times one. And you end up with this huge number. In other words, if you counted the square feet on a billboard, there might be, oh, say, two hundred square feet. And then you multiply that times two hundred. Do you know how to multiply by hundreds? Yeah, it's easy, you just keep adding zeroes. Two hundred times two hundred is a four, with four zeroes. What that meant was, there's forty thousand pounds pushing on your billboard. And they would test it to see if your billboard could hold forty thousand pounds. Well, an easy way to do that is to attach a tank to it and pull. If the billboard didn't fall over with forty thousand pounds on it, you could keep it. If it didn't, you had to make it stronger.

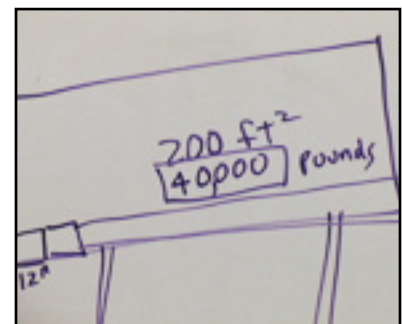
And the forty thousand pounds came from wind -- air pressure pushing on something and tip it right over, or in other cases, it can make it hover above the ground. If you took a strong wind and you blew it downwards with a fan, you could lift up heavy things in the same way. If you have something the size of a billboard with a big fan on it, you could pick up huge amounts of weight. We're going to try that later today. But first, we need a crazy story.



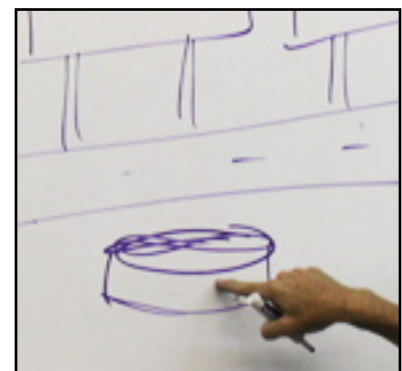
Billboard.



Billboards chopped houses in half.



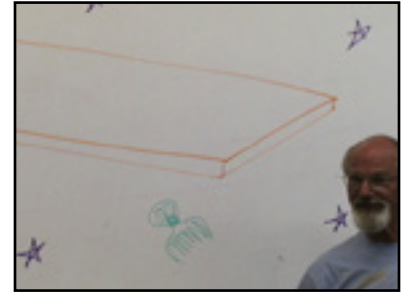
40,000 pounds of air pressure pushing on the billboard



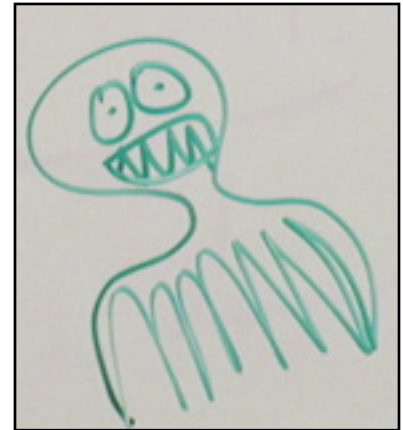
A big fan could lift a lot of weight.

Story: "Jack and Jill and the Octomonsters"

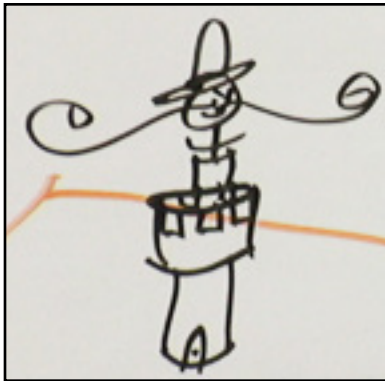
Once upon a time, Jack and Jill were living on a planet that was flat. Here's a planet that's flat, and it's floating in space. And there's purple stars all around it. And circling all around the planet there were man-eating octopuses. Man-eating octopuses with lots of arms. And they have teeth. There -- man-eating octopuses. And everybody that lived on the planet, when they had children, they'd tell their children, "Whatever you do, don't walk too close to the edge, because if you do, and you fall off, you'll be eaten by huge octopuses." And the kids said, "Oh, Mom, you're kidding. There's no such thing as huge octopuses." So the mom would take the kids over to the edge, and she would bring a cheese sandwich. And she said, "Now you stay right near this edge. I'm going to throw this cheese sandwich over, and you just watch." And she'd throw the cheese sandwich over, and next thing you know, right out from under the edge -- "Harrumfff!!" This octopus would eat the cheese sandwich and go back under the edge. And the kids would go "Huuunnhhh!!" And they'd say, "Oh, boy, we're not going to go near that edge."



Flat planet with octopus.



Man-eating octommonster.



Evil Mister Fred on his castle.

And Evil Mister Fred lived up here too. He's got a castle. And of course, it's his job to make people miserable. And so he figured, "I'm going to make a deal with those monsters. I'm going to see what they'll do for me if I throw people over the edge." Because he's evil. So Evil Mister Fred went to the edge, and he said, "Heyyy monsters! You down there?" And the monsters said, "No!" And he said, "Okay, I'll come back later." Because he's not too bright. And then later, he came back and said, "Heyyy monsters! You down there?" And they said, "What's it to you?"

And Evil Mister Fred said, "I'll feed you people if you'll do something for me." And the monster says, "Oh! Cool! Lots of people?" And Evil Mister Fred said, "Yeah! Lots of people." And he said, "What can you do for me, though?" And the monster said, "Well, we don't have much. All we have down here is gold and diamonds, and you probably don't want that." And Evil Mister Fred said, "Oooh! Gold and diamonds? Yeah, I do want that." And he says, "How much are you going to give me for each person I throw over?" And they said, "Oh, how about that person's weight in gold? So if it's a heavy person, you get lots of gold. If it's a light person, not so much gold." And Evil Mister Fred said, "Yeah, I like this!"

So Evil Mister Fred began making a plan. Jack and Jill are living here in Goodville. And they're planning an Olympics. And they want to have an olympics that has fun things. Like roller coaster rides. There's a roller coaster olympics, and the objective of the roller coaster olympics is to



Roller coaster for olympics.

juggle bowling balls while you're riding on the roller coaster, and not drop the bowling balls. Another one is the rainbow dash. You've got to run over the rainbow. And they had pole vaulting, and they had throwing small cars across the place. They had the grandma toss, where you'd pick a grandma and throw her as far as you can. All kinds of neat fun games. And they put fences all around the whole planet so that nobody would fall off.

And Evil Mister Fred said, "I have a plan. I'm going to mess up their fences and I'm going to put oil all over the ground so that they'll slip over the edge." There they go -- there's fences all the way around.

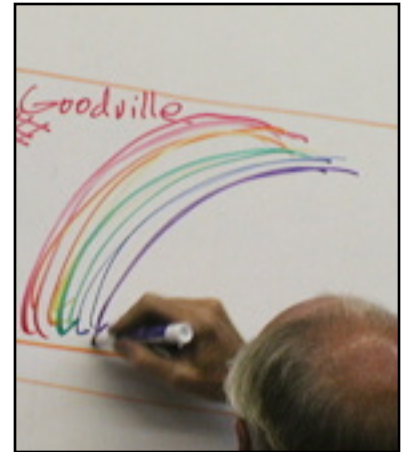
And Jack and Jill started their great contest. Everybody came to the olympics, they were watching it, there was tv coverage, there was blogging coverage, there was internet coverage of every sort. And they had the juggling on the roller coaster, and people were trying to juggle bowling balls on a roller coaster. And as they came around turns, whooahh! The bowling balls would shoot off this way or that way. You had to be really good to juggle a bowling ball on a roller coaster. And it was also compounded because sometimes the entire planet would start to tilt one way, and then it would tilt another way, like a teeter-totter. And there was a strong wind. Sometimes the wind would blow one way, and sometimes the wind would blow the other way. Of course, this all worked in Evil Mister Fred's favor.

And he said, "Minions, I've got an idea. Let's form a line here at the top, of minions. And when I say go, you're going to grab your baseball bats and run as fast as you can, hit anybody you find, and drive them all toward the other end. And then they're going to get so scared, they're going to fall off the edge. And I'll get gold for every one that falls off the edge." And he said, "Don't worry, I'll be right behind you in my bulldozer." You know what a bulldozer is? It's a big thing like a tank with a blade on it, and it pushes earth. Huge bulldozer, like that.

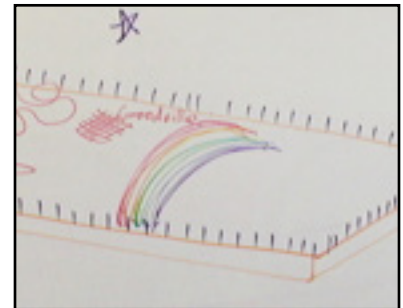
And so, Jack and Jill just happened to notice all the minions there with their baseball bats and the bulldozer, and they said, "This doesn't look good." If you were Jack and Jill, what would you do?

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 . . ."



The rainbow dash.



Fences were built all around.



The planet tilts one way and then the other.



Evil Mister Fred's bulldozer.

Experiment:

Part 1: Balloon Demo

Our first balloon is going to go under this corner [places balloon under corner of folded-up table], the second balloon under that corner. Now, there's two balloons, and they haven't popped. Hmm. Let's put balloons under the other end. [Places two balloons under opposite end of table.] Ooh, they didn't pop yet. [Places balloons under the middle of the table.] [Student], climb on the table. Now stand up, walk around to the other side. And [Student] is going to sit on the table. Sit any way you like. [Student sits on the folded-up table which is being supported by balloons underneath.] Sit down, make yourself comfortable.

Okay, we need a volunteer from the audience. [Instructor selects four more students, who sit, one after another, until there are five students seated on the table.] So far they haven't popped. [Instructor stands on the table, with the students.] Okay, now we've got five kids, and one Mr. Mac, all on the same table. [Instructor steps off the table, then directs the students to get off, one at a time, first those in the middle, then those on the ends.] That just shows you how strong air pressure can be.

Do you suppose these are super balloons, that these aren't ordinary balloons? We should test one and see if it's really a super balloon or not a super balloon. So we need somebody to step on it. [Places a balloon on the table while a student steps on it. It pops.]

Balloons pop with just a little bit of pressure in them, but there were so many balloons under there that they smooshed way out -- did you see how skinny they got? And even that little bit of pressure was able to hold all those people up without popping the balloons. And somebody that did that experiment said, "Yeah, this is great. Let's try something else."



Putting balloons under the table.



Five students on the table.



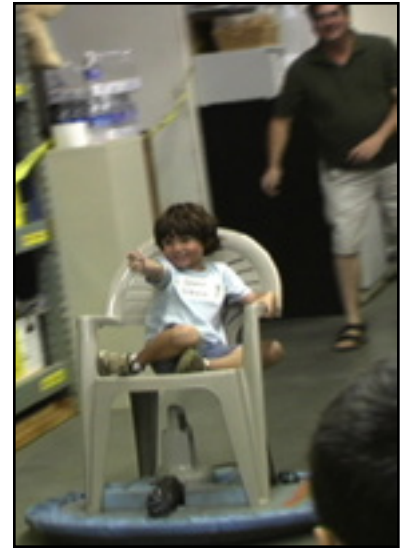
Mister Mac also stood on the table.



Popping the balloon.

Part 2: Leaf Blower Demo

So, if you take a leaf blower . . . [Demonstrates leaf blower hovercraft, with assistant sitting on it. With just a small push, it glides across the floor.] If you want to try what it's like, form a line behind Jen. You may have noticed that Jen had to balance herself. If you lean back too far, the back edge catches and it won't float. If you lean forward too far, the front edge catches and it won't float. You have to kind of balance around and see where your weight needs to be to make it float. [Students take turns sitting on the hovercraft while the staff push it back and forth.] Okay, that's a fairly simple hovercraft.



Student on leafblower hovercraft.

Part 3: Build a Hovercraft

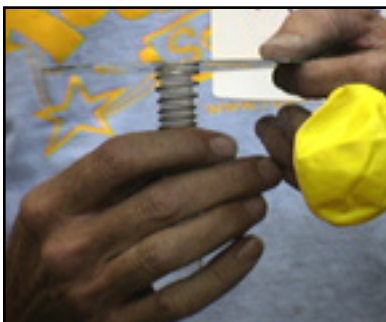
We're going to make hovercraft. To make a hovercraft, you need a test tube with a hole in it. I don't know if you can see it, but there's a little tiny hole in the bottom. Usually scientists put liquid in it. We're going to put balloons on it. And I put a balloon on the test tube.

Then we're going to put handcuffs on the balloon. They're tie wraps. The tie wrap is a plastic thing that has grooves on it. If you run your fingernail over it and listen, you can hear it. The groovy side has a finger that catches on them inside that head. So if you put his tail in his mouth and pull on his tail, the balloon is now tight on the test tube.



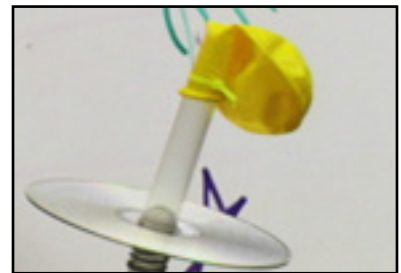
Secure the balloon with a tie wrap.

Now, hovercraft usually have a flat circle. And one of the best things for a flat circle is old CDs. A disc by itself will float pretty good, because they're flat, but it doesn't hover like a hovercraft does. We need to blow air under it. So we're going to glue the test tube on top, and when you blow up the balloon, you blow air down, and this will hover across the table.



Place the centerer under the CD.

The only problem is, it's hard to get the test tube exactly centered on the hole. So we made a test tube centerer. Here's a test tube centerer made out of another test tube. It's got a spring on it. You put that one underneath your CD, and you take your balloon one and you jam it on top. Now, it's sitting on there. It's sprung against this, and it's all centered perfectly.



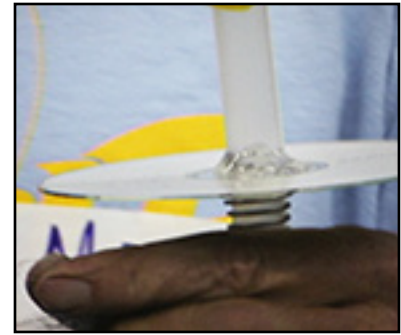
Push test tube onto centerer.

We just have to put glue on the edge below the balloon. We have to use enough glue so that no air can leak out here. [Picks up glue gun.] We would go squirt, squirt, squirt, squirt. Just squirt glue around

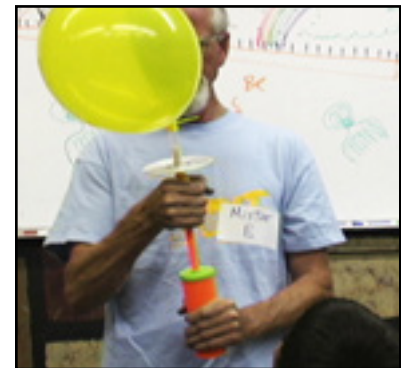
there, and twist it as you go, and when the glue is hard -- of course, it takes a hundred years for the glue to get hard. You can make spider webs on it while you're waiting, or you can color the top of it. You can also write something on there. You can decorate it any way you want.

Now, we need some way to puff it up. *[Holds up balloon pump.]* Here's a puffer. It puffers puffs when you pull out and puffs when you push in. If the glue is hard enough, just set it on there and puff it up. If you have hands attached to your arms, put your hands under the table and see if there's any gum under there. If you find it, you can have it. *[While students' hands are out of the way under the table, Instructor sends hovercraft gliding across the table.]* And now we have a hovercraft. Now, we're going to make our table smoother with a table smoother. *[Lays a large sheet of smooth cardboard on top of the table.]*

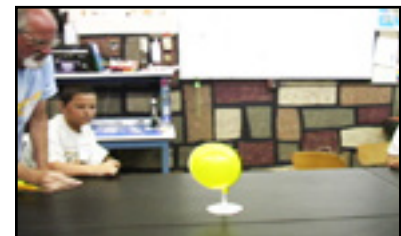
So the first thing you all need is a test tube. Then, pick a balloon. *[Supplies are passed out and students build hovercraft, testing them on the tabletop and on the floor.]*



Glue around edge of tube.



Use balloon pump to inflate.



Give the hovercraft a little push and it glides across the table.

End of Story

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

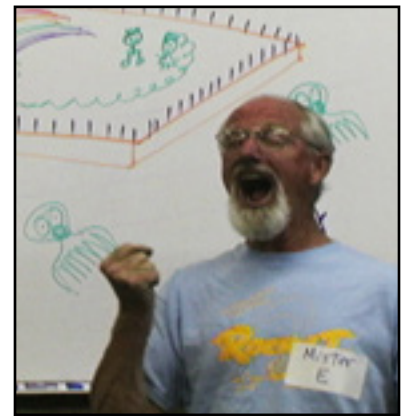
Evil Mister Fred has made an evil plan to throw people off the edge of the planet and let them get eaten up by the octomonsters. And he gets their weight in gold for every one that goes over the edge. He's rigged up a roller coaster to throw people off the edge. He's moved the rainbow so that the finish -- the ending -- is over the edge. Everything is rigged so that people are going to fall over. And Jack and Jill become aware of his evil plan, but they have to tell everybody in the whole planet. And Jill says, "Jack, you've got to warn them. Do something!" And Jack said, "What could I possibly do?" And Jill said, "Yell, really loud." And Jack said, "Okay. *[in a very soft voice]* Everybody watch out." And they didn't hear him. So Jill said, "Okay, Jack, I'll help." And when he started to yell, she pulled on his underpants, and he went *[very loudly]*, "Everybody look out!!!" And this just panicked all the people on the planet. And everybody was running around, and they all went to the local restaurant and grabbed pancakes. And then they put the pancakes on the ground, laid face down on them, and blew a hole through the middle of their pancakes. And they created so much air under the pancakes, all the people were now hovering around on pancakes. And it just happened at that very instant the wind changed direction, and the planet tilted that way, and all the pancake hover people started to fall in that direction. Millions and millions of hover pancake people. And they came down and hit the bulldozer and all the minions. And there was so much force there, the bulldozer hit the minions and pushed the minions and the bulldozer and Evil Mister Fred over the edge. And at that very instant, the planet tilted back again, and everybody else was saved. And the octopus monsters ate them all up -- the minions and Evil Mister Fred and the bulldozer and their baseball bats. 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.



Evil Mister Fred rigged the roller coaster to throw people off.



Jack yelled, "Everybody look out!!!"



The planet tilted, and everything started to slide.



The bulldozer hit the minions, and they all went over the edge.