



Teacher's Guide for:
Straw Towers

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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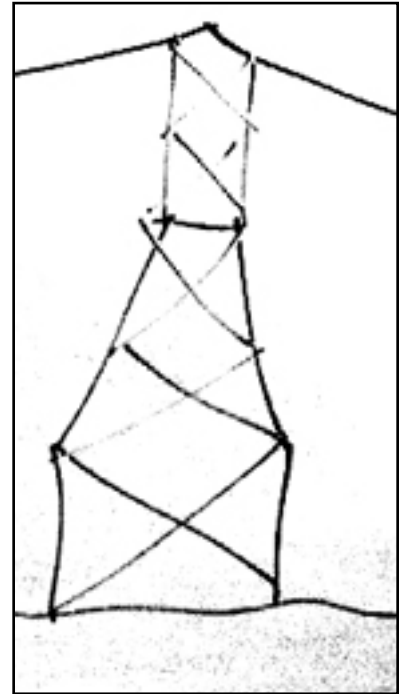
Straw Towers
A Rock-it Science Lesson
Filmed October, 2009

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Intro Quick Recap:

- Power lines have huge poles, and the lines are five hundred thousand volts.
- They go across country and have to withstand tornadoes and hurricanes.
- Their shapes contain a lot "X"s, because triangles are strong.
- They're made out of thin metal, but if you put enough of them together, you get a strong tower.
- You could make it in the shape of a cylinder and it would be strong, but it would have to be very wide.
- They don't usually make them out of squares, because squares act kind of odd.
- Instructor uses magnet construction toys to demonstrate the stability of various shapes:
 1. Flat Square -- This shape can easily distort.
 2. Cube -- This is more stable, but it can also distort easily.
 3. Square-based Pyramid -- More stable than a cube, but the base can still distort.
 4. Triangle-based Pyramid -- Very stable, no matter what position you put it in.
- The experiment will consist of building a tower 3 feet tall that will support a 3-pound weight, using paper, straws, plastic trays, tape, rubber bands, and string.
- Students will work in groups of three and have thirty minutes to complete the project.



Electrical tower with power lines.



Pyramids made from magnetic construction toys.

Experiment Quick Recap: "Straw Towers"

- When this experiment is done in college, they only use straws, but they have two hours to complete it. We only have thirty minutes, so we'll use additional materials.
- The objective is to hold a 3-pound weight 3 feet in the air.
- Students work in groups of at least three. No one gets to work alone. It's important for students to discuss their ideas and come up with solutions as a team.
- Instructor gives each team a weight, which is a steel ball wrapped in foam and completely covered in duct tape.
- All construction materials are on a cart, and students may take whatever materials they want to use, but cannot use anything that's not on the cart.
- The materials include:
 - Plastic cafeteria trays
 - Fat straws
 - Spoon straws that fit inside the fat straws
 - Rubber bands
 - Masking tape
 - Bond paper, 8 1/2 x 11
- When a group finishes their tower, the Instructor checks the height with a yardstick and confirms that it holds the weight.
- The group then weighs all the materials used for their tower (not including the 3-pound weight), and the Instructor writes the weight of each tower on the white board to see which one is lightest.
- Students can take their towers home, but not the plastic trays.



Placing the weight on top of a tower.

Equipment List: "Straw Towers"

Items needed for Instructor:

- Magnetic construction toy pieces (commercially available)
- Scale, to weigh students' tower materials

Items needed for Students:

Consumables (per student):

- Paper, 20-lb bond, 8 1/2" x 11" (about 100 sheets)
- Straws, spoon-style, 8 1/4" (about 1,000)
- Straws, fat, 8" (about 1,000)
- Tape, masking, 3/4" (one roll per group)
- Rubber bands (about 100)
- String (one spool)

Other:

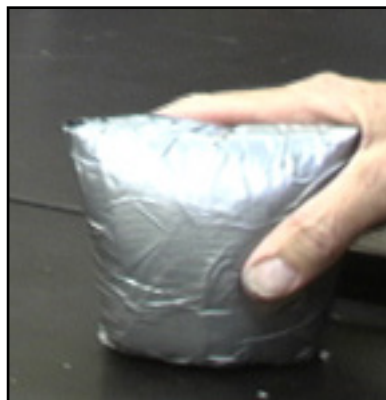
- Trays, plastic cafeteria-style (about 15-20)
- Scissors
- Weight, 3-pound (6 ea.)

Prep Work:

- Make 3-pound weights, using a steel ball surrounded with foam and securely wrapped in duct tape.
- Assemble all student construction supplies on a cart.



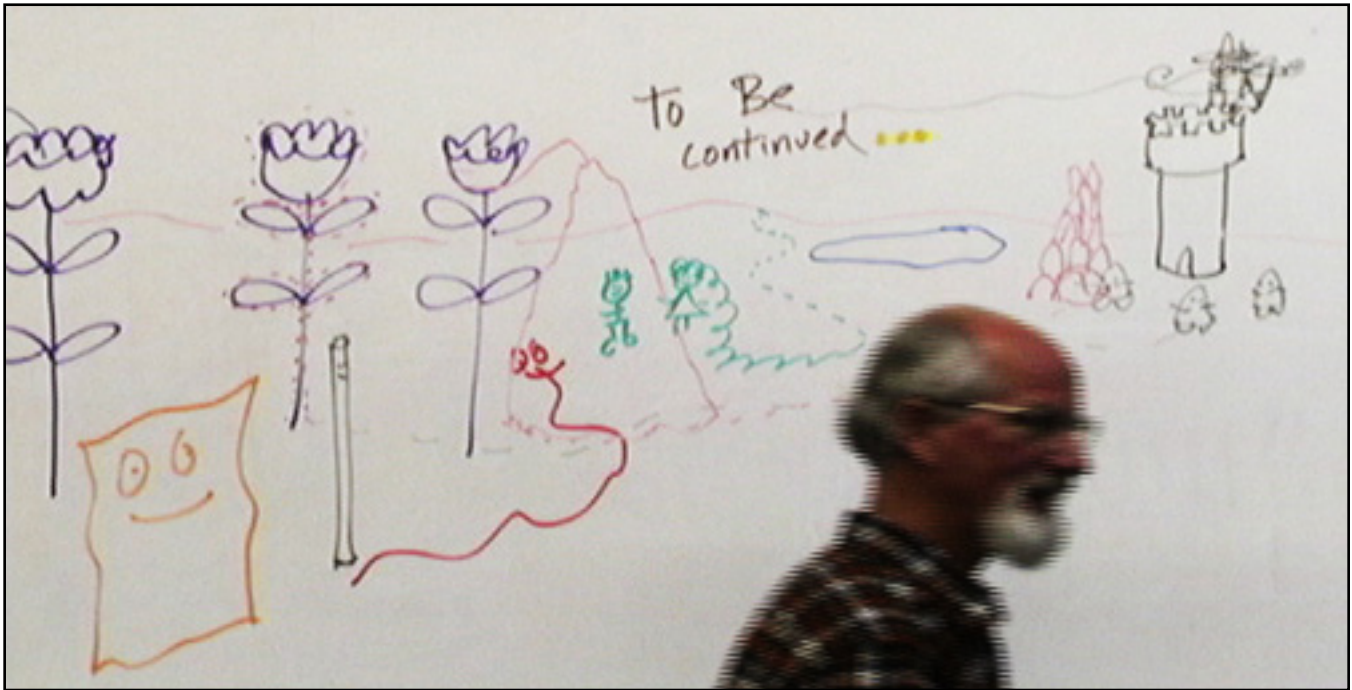
Magnetic construction toys.



3-pound weight.



Story Recap: "Jack and Jill and the Fire Ant Nectar"



Part 1:

- There was a place where strange creatures lived. Some were tall and skinny; some were thin, like paper; and some were like spaghetti.
- The creatures were immortal because they drank the nectar from giant purple petunias. If they don't get the nectar, they quickly fade away and die.
- The flowers are covered with fire ants. If a fire ant touches you, you burst into flame.
- To get to the nectar inside the flower, the creatures use their bodies to build a tower that's higher than the flower so they can reach into it without touching the fire ants.
- The creatures are endangered species, so Jack and Jill are looking out for them to make sure no one steals the nectar.
- Evil Mister Fred wants the nectar so he can live forever. He sends his minions to climb the flowers and bring back the nectar.
- The minions touch the fire ants and burst into flame. Evil Mister Fred tells them to jump in the lake to put out the fires.
- Then he gives them bubble gum. The minions start blowing bubbles, which burst all over themselves. Then they start climbing on top of each other and make a tower of their bodies, stuck together with bubble gum.
- The minions go back to the flowers, but the base of their tower is too wide, so it touches the fire ants before the top of the tower can get close enough to the blossom.
- One minion has a really long mustache, and it stands at the top of the tower and tries to lasso the flower and bring it closer. But when the mustache touches the flower, it bursts into flames.

Story Recap (cont.): "Jack and Jill and the Fire Ant Nectar"

- Evil Mister Fred uses his vacuum cleaner to hover over the flower and steal the nectar himself. But as soon as he grabs it, he bursts into flame and has to do a crash dive into the lake.
- He calls the Acme Store of Everything and orders a fireproof suit, fireproof gloves, and a helmet.
- Jack and Jill try to persuade the creatures to move away from there so they'll be safe, but they won't leave.



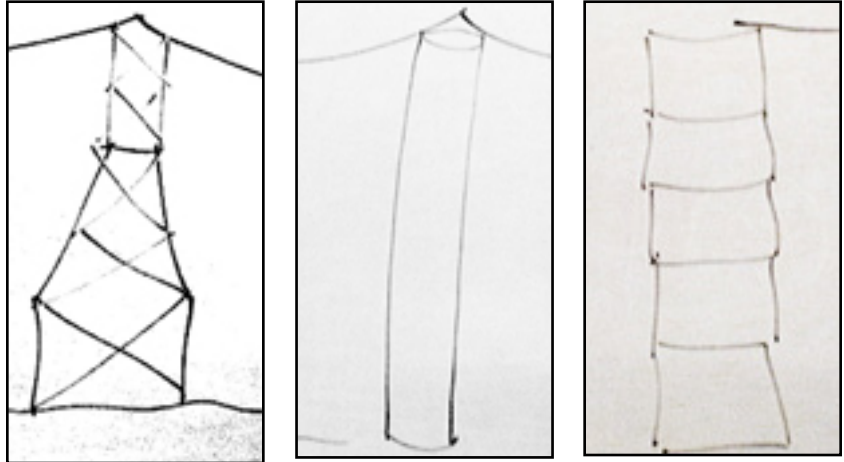
Ending:

- Jack and Jill called the Acme Store of Everything and ordered a duplicator box and made thousands of copies of the straw, paper, and string people.
- They built a very tall tower with a huge fake purple petunia on top.
- Instead of nectar, this petunia was filled with the fire juice from the fire ants.
- Evil Mister Fred flew over in his fireproof outfit, thinking he was invincible.
- He sucked up all the fire juice in his vacuum cleaner.
- He couldn't wait to drink the nectar of immortality, so he poked a hole in the vacuum bag, stuck in a straw, and drank a big gulp of the fire juice.
- There was a huge ball of fire in the sky.

Transcript: Intro

Okay, you've probably heard about power lines, the huge poles and the lines that are five hundred thousand volts. They go across the country, and they have to withstand tornadoes and hurricanes. They have a funny shape. There's a lot of "X"s in the towers, and the X's are there because triangles are strong. Triangles are your friend.

Now, this has been proven to work, made out of thin metal, but if you put enough of them together, it makes a really good tower. If they wanted to, they could make a tower of a cylinder. That would be pretty strong as well. But it would have to be kind of wide in order to work well. They don't usually make towers out of squares, because squares usually act kind of odd. And we can show you how this works with some toys.



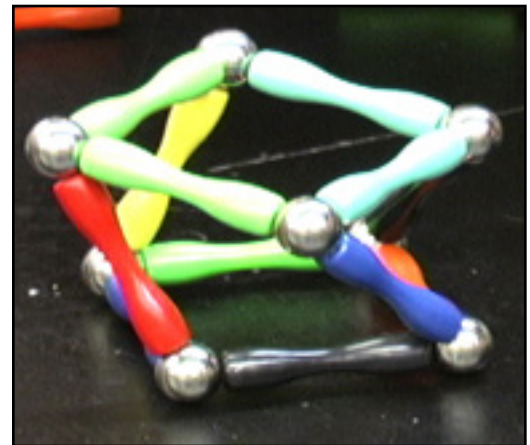
Towers made from triangles, a cylinder, and squares.

We have these magnetic toys. Each one of these has a magnet in the end. You can stick a ball on there, and you can let them come together any way you want.



A square twists out of shape easily.

We'll start off with a square. Squares are kind of squishy, and if you build up some sides on it, we're going to make a cube out of the thing and see how that acts.



A cube also distorts easily.

We can build ourselves a square shape -- there. Now we can see that a square can go together pretty well to make a cube, but it is really weak.

So we'll take it apart and turn it into a pyramid shape. And now it's a lot stronger than before, but still the base is not very rigid. If you turn that into a triangle pyramid, then all of the ways that we set it, it has the same amount of strength.



Triangle pyramid (at left) is stronger than a square-base pyramid.

So today you guys are going to be building a tower out of something. If you want to, you can make it in a framework, hopefully with lots of triangles, and build it up as a framework. Or, you can build it out of sheets of paper. And the paper you can form any way you like, but we've seen that circles can be quite strong for paper. And you can use for a foundation one of these trays. Whatever you build, you can tape it onto that with some duct tape.

And you want to build something that's three feet high. And on top of it we're going to put a weight. The weight consists of a three-pound bundle. There's a steel ball in there, and it's a nice heavy bundle. All you have to do is support it three feet in the air with all the stuff that's on our cart. And you'll need to work in groups, no less than two people in a group, preferably three, because there are six balls, and three people works perfectly. Hopefully, you'll find things to argue about and settle your arguments so you can make a tower in thirty minutes.



Paper cylinders can be strong.

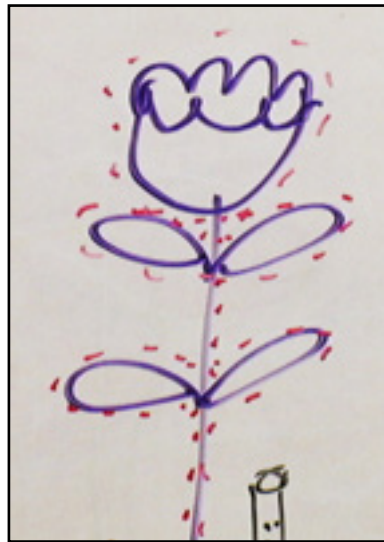
Story: "Jack and Jill and the Fire Ant Nectar"

Once upon a time, there was a place where some strange creatures lived. Some of them were tall and skinny, with eyes like that. And some of the creatures were thin, like that. And some of the creatures were like spaghetti. There. And all these creatures were immortal. They never die. They live on forever.

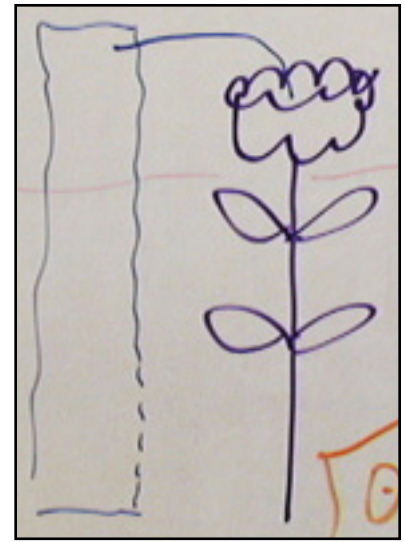
They live on forever because in the place where they live, there happen to be some flowers -- purple petunias. And the flowers have nectar in them. And the creatures drink the nectar from the flowers. As long as they drink the nectar, they stay alive. But if they don't get the nectar, they fade away very quickly and die.

They have to get to the nectar itself. Unfortunately, the flowers are covered with fire ants, and if a fire ant touches you, you burst into flame. So they're all covered with fire ants.

And so these creatures, what they do whenever they need some nectar out of the purple petunias, they create a structure out of themselves. Now, these paper guys can roll up to make a cylinder, and the tube guys can create structures out of themselves, and the strings can tie everything together. And they create some sort of a structure, so that they can have a tower next to the purple petunias. And then one of them has to reach in and get the nectar out. Well, if any fire ants touch him -- poof -- he bursts into flame. That's not good. But they have figured out a way to do it.



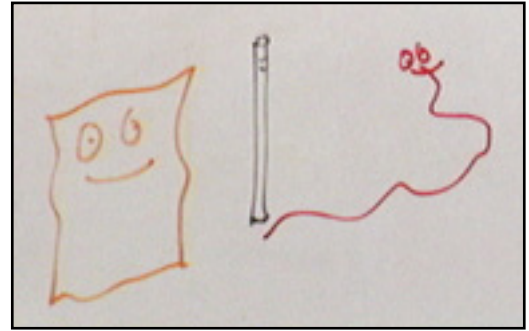
Petunia covered in fire ants.



Tower to reach nectar.

Now, the whole area is being watched over by Jack and Jill. They're supposed to protect these creatures because they're endangered species. And they don't know exactly how the creatures get the nectar out of the flowers, but they're just trying to make sure that someone doesn't come along and steal the nectar.

And of course, that someone is Evil Mister Fred, who has set up camp nearby. And he wants to live forever, so he figures, well, if they live forever by eating the nectar from the purple petunias, he can do it, too. All he has to do is get it from them.

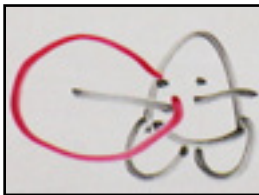


Strangely shaped creatures.



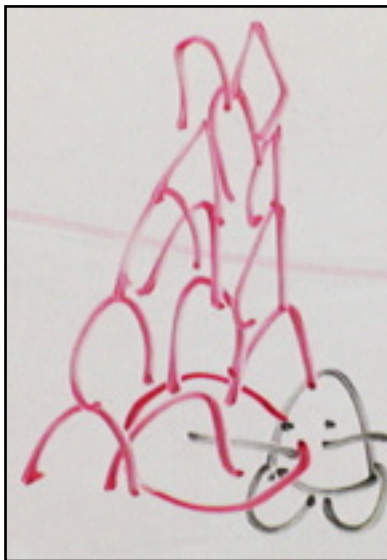
Jack and Jill watch over the creatures.

So he's told his minions to run over there and climb up the flowers and steal the nectar. So the minions said, "All right! We can do this!" And they run over there and next thing you know -- poof -- you've got flaming minions. And they're all running around screaming. And Evil Mister Fred, you know, he doesn't say, "Aw, that's too bad, you burned up." He says, "You idiots! What's wrong with you? Stop burning!" And they go jump into a lake or something to put themselves out.



Minion's bubble.

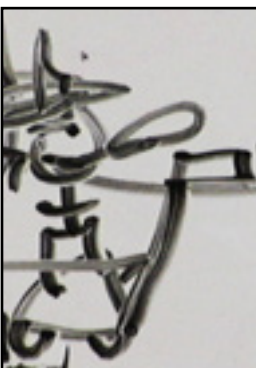
And so he says, "Okay, minions, here's some bubble gum. Go for it." The minions ate the bubble gum. Of course, minions can't just chew the bubble gum. They blow bubbles. And when they're blowing the bubbles, the bubbles pop. And now you have a minion covered



Pile of gummy minions.

with bubblegum. And when you get minions covered with bubblegum, and other minions run into him, you get a pile of minions all stuck together.

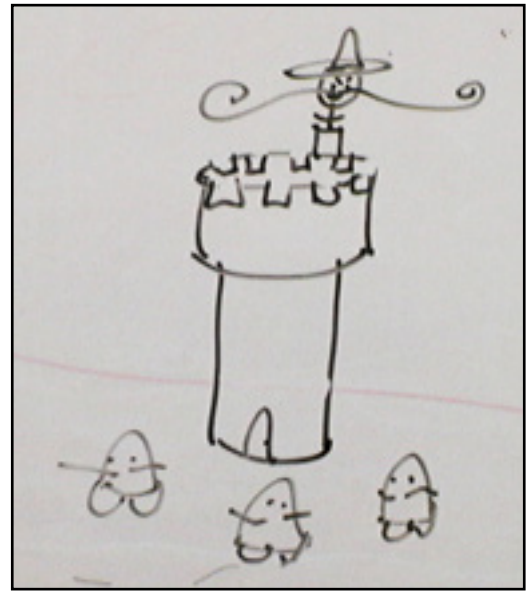
Pretty soon they had this pile of gummed-up minions. And they're getting taller, like that, because they're climbing on top of each other because they like to do that. And Evil Mister Fred said, "Okay, now you've got it! Go over to the flowers and get some of that nectar."



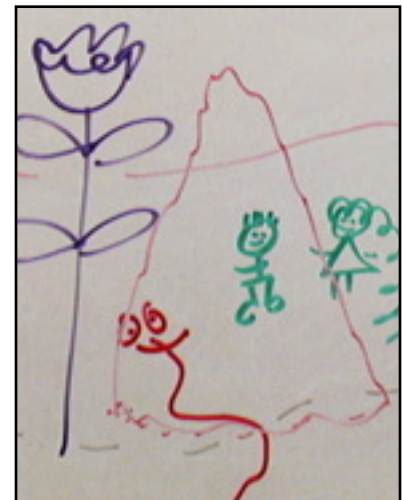
Evil Mister Fred on his vacuum.

So here's this whole pile of gummy minions, going over there. And they actually make a nice big tall pile. But the bottom of the pile would touch the flower before the top of the pile gets to where it is. So he says, "Use your mustache! Use your mustache!" And there was one minion with a really long mustache. And he was supposed to lasso the flower and pull it over to get the nectar out. Of course -- poof -- his mustache touched it and burst into flames. And Evil Mister Fred was trying to figure out how to do this. And then he said, "Oh! Stupid me! I've got the answer right here!" There, right behind him, was his vacuum cleaner. He says, "All I've got to do is fly over there, steal the nectar, and away I'll go."

So Evil Mister Fred flies right over there, and he's hovering right over the top of the flower. He can see the fire ants, but he can see there's a nice clear spot. He



Evil Mister Fred and his minions.



Pile of minions tries to get close to the flower.

reaches in, grabs the nectar, next thing you know -- foom! -- Evil Mister Fred is on fire. And he has to do a crash dive into the lake to put himself out.

So Evil Mister Fred called the Acme Store of Everything and he ordered a fireproof suit, and fireproof gloves and helmet, and all kinds of cool stuff. And Jack and Jill said, "Oh, boy. Sooner or later, he's going to find a way to get that nectar. We've got to think of something."

And Jack and Jill are trying to persuade the creatures there to move somewhere else, to protect themselves from Evil Mister Fred. They say, "Aw, no, we're not leaving. We'll be okay." Now, if you're Jack and Jill, and you want to get the nectar out of there, and move all the creatures, 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: "Straw Towers"

Now, a very simple experiment. They do it in college. In college, they only give you straws. But they also give them two hours. So you don't have two hours. What the objective is, is to put this weight -- it weighs three pounds -- about that height in the air. And make it stay there. *[Student: For how long?]* Oh, I don't know. A hundred years?



Spoon straw fits inside fat straw.

So you have to build something under it. And we're going to make it a little easier for you. You get a dinner tray to build something on. You put a dinner tray down there, and then you can somehow fasten stuff to it and create a tower. For your tower, we have lots of straws. There's black straws. There's a bunch of spoon straws. You ever mess around with spoon straws? *[Student: You mean like for slushies?]* Yeah, like for slushies. They have kind of an open end on them that looks like a spoon. The neat thing about the spoon straws is, if you need it for some reason, the spoon straws fit inside of the black straws. So you can make straw structure things.



Plastic tray.

There's lots of rubber bands. There's masking tape. There's lots of sheets of paper. And there's lots of string. *[Student: Can you tape the weight to the straws?]* You can. The idea is to make the weight stay up there. The weight is three pounds. It's kind of heavy.

Now it would be reasonably easy if you did it by yourself, so nobody gets to work by themselves. You need to be in a group of three. When you have

a group of three, all three of you come up here and I'll give you a thing. *[Students organize themselves into groups and come forward. Instructor confirms that there are three in each group, then gives each group a weight.]*

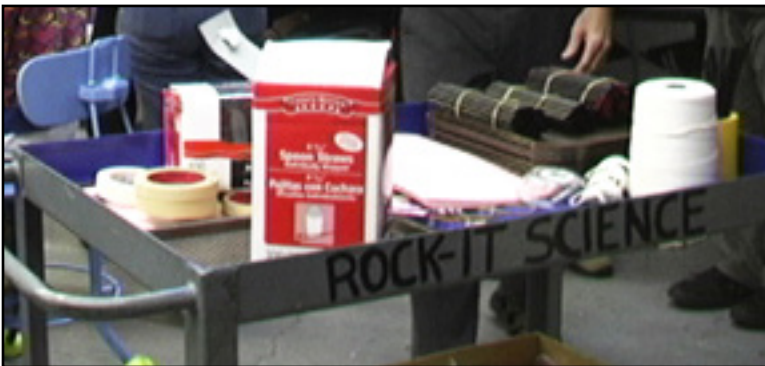
So now there should be groups of people, and you can come up here and take whatever you think you might need. *[Students take whatever supplies they*



Three-pound weight.

plies they want and return to their seats and start building.] You want it to end up being about three feet high.

[When a group gets their tower completed, Instructor checks the height with a yardstick and confirms that it will support the weight. Then the group takes all of the materials that were used to build their



Construction supplies on cart.

tower and places them on a scale to weigh them (without the three-pound weight). The Instructor writes the weights of the various towers on the white board so they can see which one is the lightest.]

[In this class, one group of students was very close to completing their tower, so the Instructor allowed the construction time to run longer. This meant there wasn't time to finish the story.] Okay, we're going to finish the story next week. We need to clean off the table. If you want to take your tower home, you can take it home, but you don't get to take the trays home.



End of Story

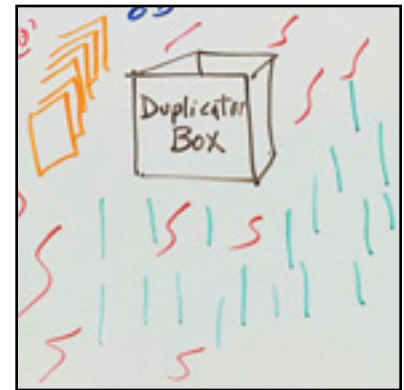
*** DO NOT *** present this part of the lesson until after the experiments!

NOTE: Story ending does not appear on the video.

When we left them, evil Mister Fred had bought a fire-proof suit from the Acme Store of Everything and was planning to get some of the nectar of eternal life out of the purple petunias.



Jack and Jill called the Acme Store of Everything and ordered a duplicator box and made thousands of copies of the straw, paper, and string people who then built themselves into a very tall tower with a huge fake purple petunia at the top. But this purple petunia didn't have the nectar of eternal life inside... it was filled with the fire juice from the fire ants!



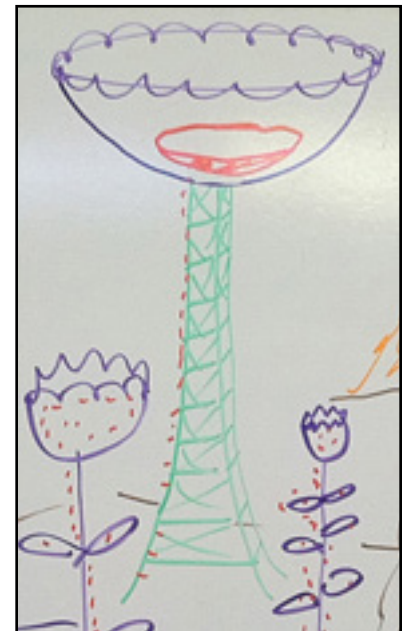
Duplicator box made thousands of copies of the creatures.

Evil Mister Fred flew over wearing his fireproof suit thinking that he was now invincible. When he saw the huge petunia on the tower he said, "Ha! They think I can't fly up that high... I'll show them!"

Then evil Mister Fred flew right up into the Purple petunia and sucked up all the fire juice with his flying vacuum cleaner. Evil Mister Fred was so happy he couldn't wait to get back to his castle, so he poked a hole in the vacuum cleaner bag, stuck in a straw, and drank a big gulp of the fire juice. There was a huge ball of fire in the sky... and they all lived happily ever after, except evil Mister Fred.



Evil Mister Fred in a ball of fire.



Fake petunia with fire juice inside.

End of Lesson

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