



Teacher's Guide for: **Hero's Fountain**

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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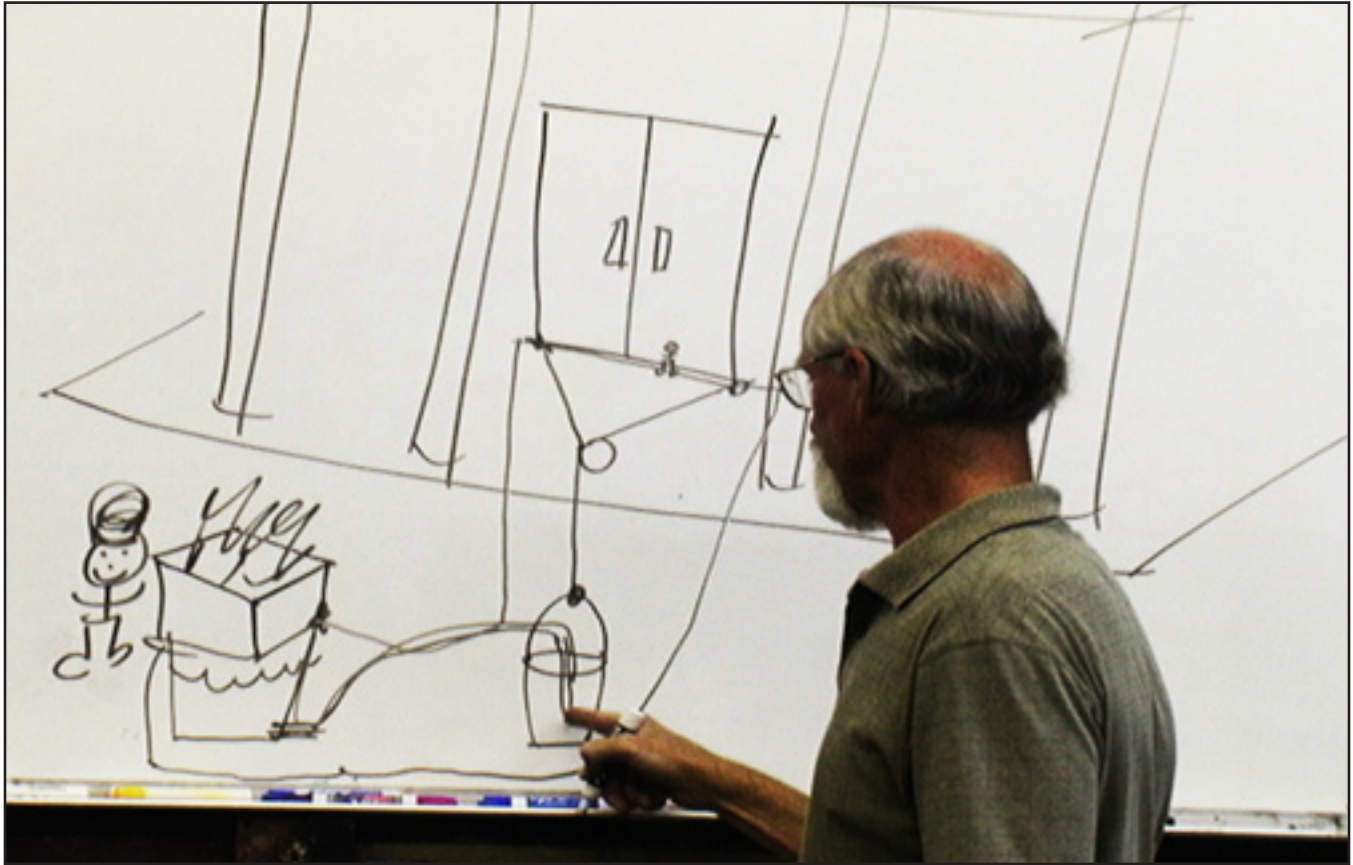
Title Page of Video

Hero's Fountain
A Rock-it Science Lesson
Filmed November, 2009

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Intro Quick Recap: "Magical Doors"



- Hero lived a long time ago. He knew how to write and draw pictures. He collected all the smart ideas people had and put them into a book.
- In those days, to make a book, you had to do a lot of work to make the parchment and ink. It could take a week to make one page, and Hero wrote hundreds of pages.
- One thing Hero wrote about was a temple with big columns and a pair of giant doors. The priest would stand in front of a big fire in front of the temple and chant, and at the right moment, the doors would swing open by themselves.
- Hero showed how the priest was using heat, air pressure, and water to make the doors open. The fire was built atop an airtight box with a tank of water under it. Under the box was a tunnel leading to the temple doors. The heat of the fire would make the air in the box expand and push out the water. The water would travel through a tube to a large bucket suspended in the air. The bucket was connected by pulleys to the temple doors. As the water filled the bucket, the bucket would get heavier and sink toward the ground, which would pull on the doors, making them open. Later, when the fire cooled off, it would create suction inside the box, and the water would get sucked back. This made the bucket rise up again and the doors closed.
- Hero became famous for writing about all these brilliant inventions, but he didn't invent them himself.

Experiment Quick Recap: "Hero's Fountain"

Part 1 -- Squirting Bottles.

- NOTE: The beginning of this experiment is missing from the video. Mr. Mac gave each student a bottle of water and a cork with two tubes in it. By attaching a drinking straw to one of the tubes and blowing in it, the students learn how air pressure can make the water spurt out from the other tube.



Part 2 -- Build a Fountain

- Teacher shows students a group of three corks connected by various clear flexible plastic tubing. He inserts the corks into two 3-liter soda bottles and adds a plastic funnel-like section to create the fountain apparatus.
- Tell students to leave one bottle empty, and to fill the other with water. *DO NOT tell them which bottle gets the water.*
- After setting up the apparatus, students will use a clear plastic cup to pour some water into the funnel part and see what happens.
- If nothing happens, students need to try something different. Eventually, they will all get their fountains working.
- The next part is to find a way to make the fountain spurt higher. *DO NOT tell them that changing the relative heights of the bottles will change the way the fountain spurts.*



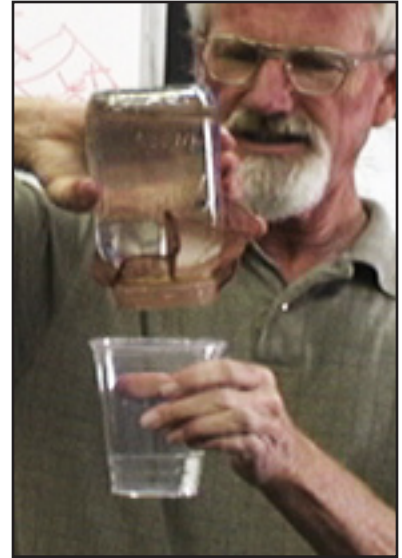
Fountain Apparatus

Experiment Followup

- Back in the classroom, the Teacher reviews the fountain experiment, explaining how the air and water flow through the various tubes and end up squirting out the funnel. Ask students: Where does the air come from?
- The people who use this fountain in the olden days used it for parties. They put wine in it and used a really large barrel in place of the water bottle, so the wine would flow all day long.
- Ask students what will happen if you remove the cork from the empty bottle, and demonstrate. Then ask them what will happen if you remove the cork from the other bottle, and demonstrate.

Part 3 -- Upside-Down Water

- Put away the fountain apparatus and bring out a glass canning jar with the opening covered with a piece of pantyhose, held in place with a rubber band.
- Tell students you're going to pour water into the jar. Ask them if they think the water will go through the cloth.
- Pour water into the jar through the cloth until it's full. Then ask students if they think a plastic cup will hold all the water in the jar (the cup is a little smaller than the jar).
- Teacher quickly upends the jar above the cup and only a small amount of water pours out.
- Teacher holds the upended jar above one student's head and tells him to poke the cloth. This makes a little bit of water come out. Teacher lets each student take a turn poking the cloth.
- If you were serving wine at a party with this jar, you could tilt it on an angle and the wine would pour out into a glass. When you want to stop pouring, you could turn the jar completely upside down.
- After emptying the jar, the teacher again tries to pour water through the cloth, but most of it doesn't go through. Ask students why they think this happens. It's because when the cloth is wet, the air can't get through as easily. When the experiment started, the cloth was dry.



Only a small amount of water pours out.

Equipment List: "Hero's Fountain"

Items needed for Instructor:

- Tables set up outdoors
- Buckets, 5-gal, for water (about 4-5)
- Jar, glass mason
- Panty-hose, about 8" square
- Rubber band to fit rim of mason jar
- Cup, clear plastic, 16-oz
- Water

Items needed for Students:

Consumables:

- Plastic drinking straw
- Water, about 3 liters per group

Other:

For Experiment 1, Squirting Bottles (per student):

- Bottle, plastic, 1/2-liter
- Cork, plastic, #4 with 2 holes, to fit 1/2-liter bottle
- Tubing, clear plastic, flexible, size to fit snugly inside plastic straw, one piece about 1-ft length, the other about 4"

For Experiment 2, Hero's Fountain (per group of 2 students):

- Bottles, plastic, 3-liter (3 per group of 2 students)
- Corks, plastic, size to fit a 3-liter bottle, with 2 holes in each (3 per group)
- Tubing, clear plastic, flexible, to fit the pipette (about 9 ft per group)
- Pipette, clear plastic, disposable, 10 ml. (3 per group)
- Cup, clear plastic, 16 oz. (1 per group)

Prep Work: (See photos on following pages)

For Experiment 1:

- Cut tubing into 1-ft and 4" lengths
- Insert tubes into corks, with longer one extending to the bottom of a 1/2-liter bottle. (see photo)

For Experiment 2:

- Cut tubing into 4-ft lengths (2 each)
- Cut tubing into 1-ft lengths (1 each)
- Cut tubing, about 1" long, to join sections of pipette.
- Cut the top off a 3-liter bottle about 2/3 of the way up to make a funnel (1 each)
- Drill 2 holes in each cork to fit the pipettes
- Cut the nozzle off one of the pipettes (1 each)
- Cut one pipette shaft into small sections, about 3" long (2 each)
- Assemble large tube-and-cork apparatus (see next page), using 3 corks, 2 @ 4-ft lengths of tubing, 1 @ 1-ft tubing, 1 @ 1-in. tubing, 1 @ pipette shaft with nozzle, 1 @ pipette shaft w/o nozzle, 2 @ 3" pipette shaft segments.

Equipment List, cont.:

For Experiment 1, Squirting Bottles:

- The 2 pieces of tubing are inserted into the cork ahead of time.
- The student needs to insert the end of the short tube into a drinking straw before blowing into it. Then use a new straw for each student.
- Use whatever size tubing will fit inside the plastic straw you have. (In this photo, there's an extra piece of a straw on the end of the tubing because our drinking straw was too large for the tubing to fit snugly inside it.)
- Depending on the size of your tubing, you may need to drill out the holes in the cork.

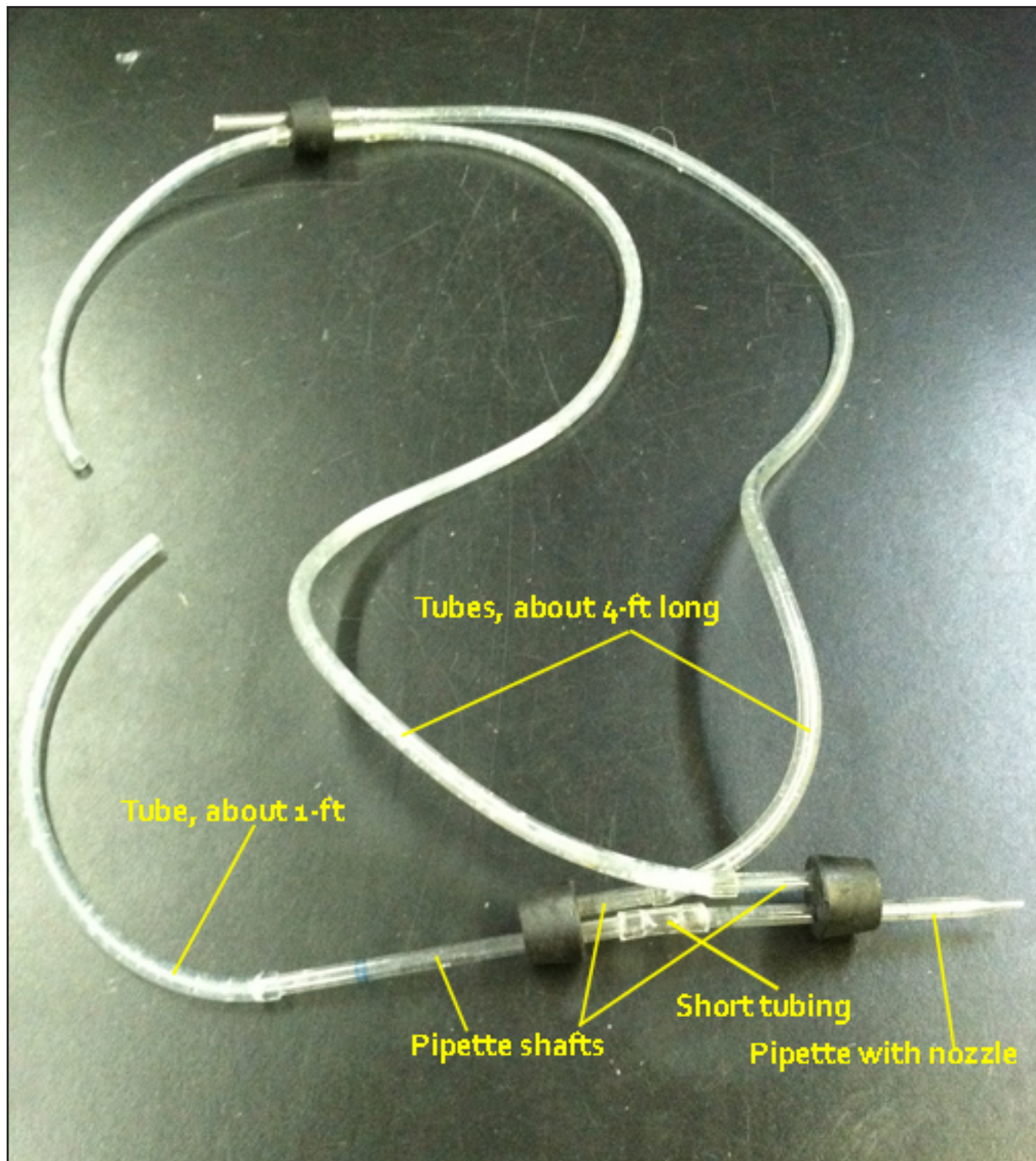


For Experiment 2, Hero's Fountain:

- Here's the fountain apparatus, fully assembled. It uses two 3-liter bottles, plus a third 3-liter bottle cut off to make the funnel. See next page for a photo of how the corks and tubing are put together. This is done ahead of time, so the students just have to plug in the corks.

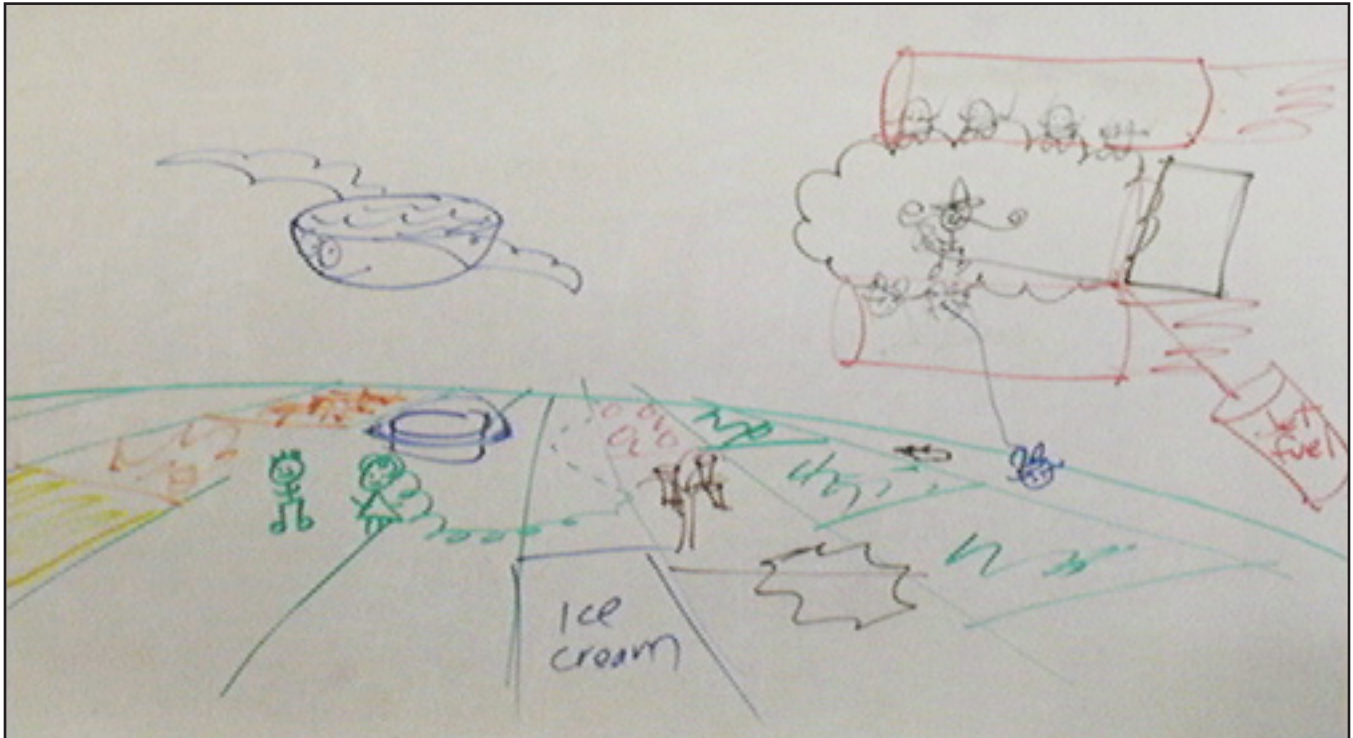


Equipment List, cont.:



For Experiment 2: Here's how the corks and tubes fit together to make the fountain. The cork with the pipette nozzle in it plugs into the bottom of the funnel, and the other two corks plug into the 3-liter bottles.

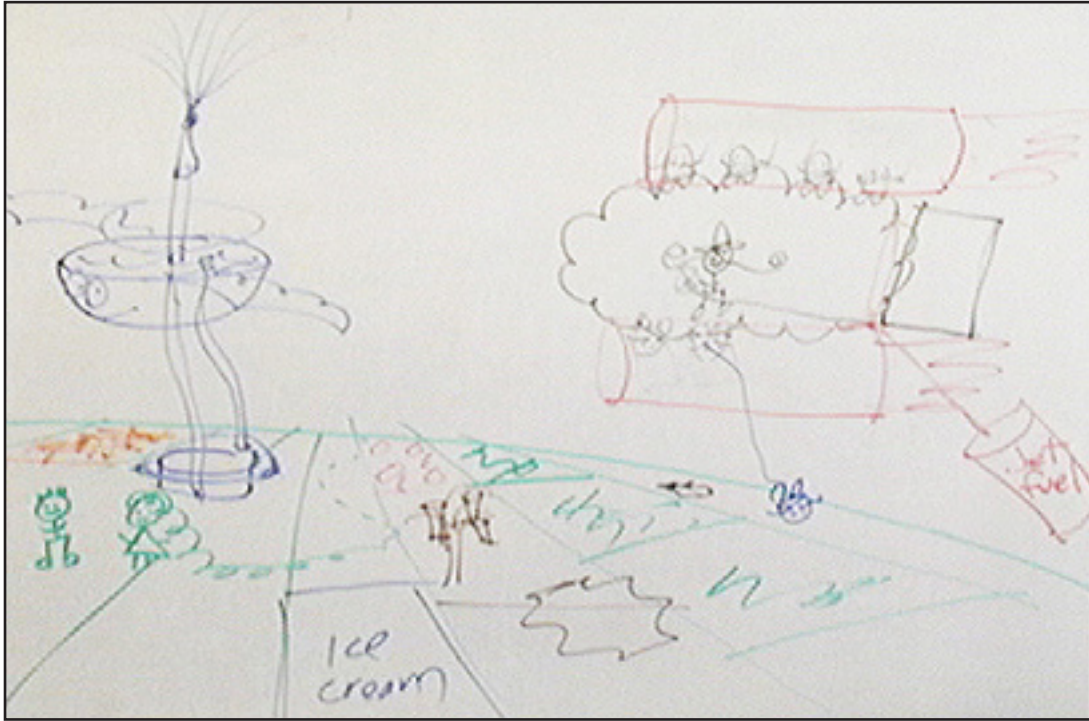
Story Recap: "Evil Mister Fred's Rocket Cloud"



Part 1:

- Evil Mister Fred wanted to improve his flying cloud. He had a bunch of minions stand on it and blow as hard as they could to make it go faster. But they all blew in different directions, so it didn't work.
- Then he gave them sheets of cardboard to fan with. The all fanned in the same direction, but they were bugging each other and ended up fighting instead of making the cloud go faster.
- So Evil Mister Fred called the Acme Store of Everything and ordered a jet engine and a big barrel of jet fuel. But having just one engine on the top of the cloud made it unstable, so it would tumble through the air instead of flying straight. So he bought another engine and attached it to the bottom.
- Jack and Jill were being green -- green faces, green hair, green clothes, green shoes, and they were growing green crops. Cabbages, corn, watermelons. Jack also grew some non-green crops: pizzas, chocolate milkshakes, tortillas, nachos, cheese, and ice cream. When the crops got ripe, they'd turn brown.
- Evil Mister Fred started stealing the ripe crops by dragging a minion from the cloud on a long rope so it could grab the crops.
- Then he would fly really low, turn his cloud to face straight upward with the jet engine exhaust directed toward the ground, and fire it up, so the crops would catch fire
- Jack and Jill called The Acme Store of Everything and ordered a flying lake. The lake would follow Evil Mister Fred's cloud around and drop water on the crops to put the fires out.

- Jack and Jill also bought a second lake that they put in the ground in case Evil Mister Fred figured out a way to stop the flying lake. They put a cover on it to protect it.
- But Evil Mister Fred could burn crops faster than Jack and Jill could grow them.



Ending:

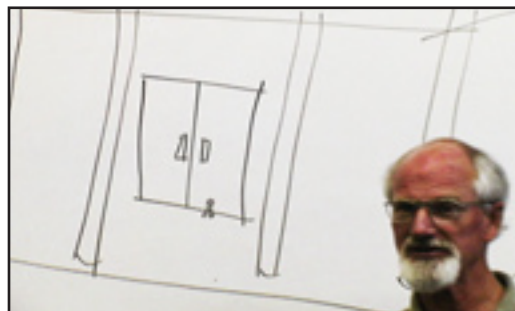
- Jack and Jill put some hoses between the two lakes, like the fountain hoses. And they put a funnel on it with tubes. They thought that Evil Mister Fred would fly through the fountain and the water would get into his jet engines and stop them.
- But Evil Mister Fred realized it was a trap and stayed away from the fountain. So Jack and Jill had to try something else.
- They called the Acme Store of Everything and ordered a barrel of super powerful XXX jet fuel and offered it to Evil Mister Fred as a gift. They thought it would make him happy so he'd be nice. He took the gift, but he wasn't nice.
- He filled his barrel with the new jet fuel, but the old fuel was still in the fuel hoses. So he took off at regular speed and positioned his cloud facing upward, about to burn up some crops.
- Just then, the XXX fuel came through the hoses, and when Evil Mister Fred fired up the engines, the new fuel was so powerful, it took off so fast that Evil Mister Fred was smashed onto the floor like a pancake. The rocket kept going all the way to Pluto.

Transcript: Intro

Once upon a time, a long, long time ago, there was a guy named Hero. Hero knew how to write, and he knew how to draw pictures. In those days, not very many people knew how to write or draw pictures. And Hero decided he was going to collect all the smart ideas that people had and make a book.

In those days if you wanted to make a book, you first had to kill a calf or a sheep, skin it, and then scrape all the hair off the skin, and then scrape the skin till it's really thin, and then dry it all off. And then you have to take some ashes from the fire, use the blackest ashes, mix them with a special kind of oil, and then take a feather from a bird, sharpen the end, and make a pen out of it, dip it in the black gooey stuff, and write on the calfskin, one page at a time. It could take a week to make one page. And Hero made hundreds and hundreds and hundreds of pages of stuff. And he collected all these great ideas and passed them down to people so we could see what they made in those days.

One of the things that Hero made was -- they had a great big temple-like thing. You know, they liked to make temples that had lots of columns. *[Student: Where was this?]* Alexandria is in northern Egypt on the Mediterranean. And let's suppose they make some Greek columns because it looks cool. So here's this big temple, and here's a guy standing. He's a regular-size guy standing by the temple doors. They're big doors. And somebody figured out a way to trick everybody into thinking that they had magical powers.



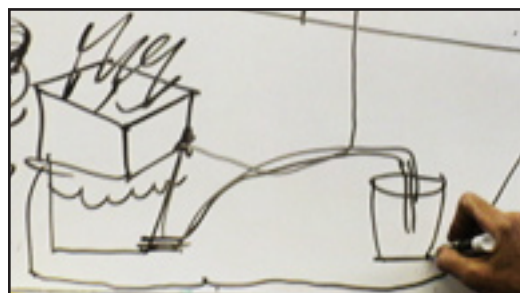
Temple doors



Fire on top of airtight box.

Right outside the temple they had a place where they lit a fire. And the guy would stand out there and look real mysterious and mumbo-jumbo and stuff, like that. And then when he was ready, he would say, "Doors open!!!" And there'd be nobody there, but the doors would magically open up. And everybody would go, "Ooooh! Aaaahhh! Ooooh!" because this was a couple of thousand years ago. And they'd all run in and say, "Man, that guy knows magical powers!"

Well, he didn't know magical powers, but he did know how to make tunnels. And he'd created an underground room under the fire. And the underground room went all the way over to these temple doors. And down there he had put a big tank of water. And when he lit the fire on the top of the box -- it was an airtight box -- the air would expand and create pressure, which would want to push the water out of the box.



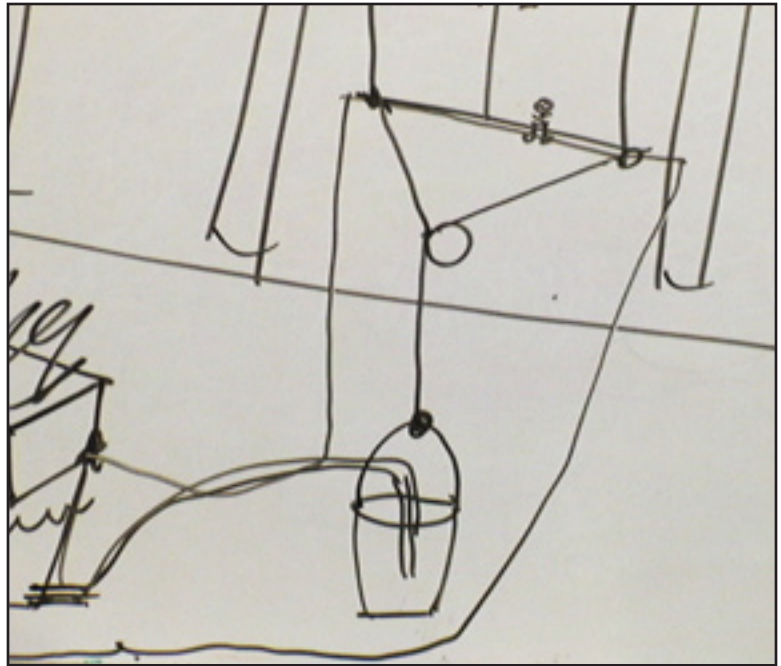
Water under fire box, with hose leading to bucket.

And there was a tube there that went into a big bucket, like that. The water's going to go out and fill up the bucket. The bucket wasn't sitting on the ground, though. It was suspended in the air by a rope. And the rope led by pulleys over to the doors. And when the bucket got heavy enough, the weight of

the water would make the doors open as the bucket went down to the ground. And everybody'd think he was really smart, because he -- actually, he was really smart.

And then, when the fire had cooled off, it would create suction inside the box, and the water would get sucked back in to where it started from, and the doors would close. So he just had to know when to say, "Ooga-booga!" so that the doors would open.

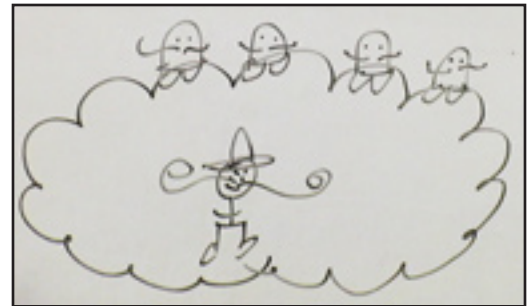
So Hero got to be famous for all these great contraptions that he wrote down. He didn't really invent them, but he was the first guy to draw pictures of them and tell how they work. Today we're going to use one of Hero's inventions, and see if you can figure out how it works.



Bucket is suspended from a rope attached to pulleys. When bucket fills, it drops and pulls the doors open.

Story: "Evil Mister Fred's Rocket Cloud"

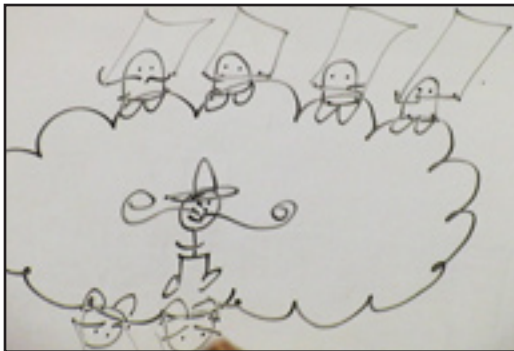
Once upon a time, Evil Mister Fred was trying to improve his cloud. He had a nice cloud. He could walk on his cloud, or he could walk inside his cloud, and his cloud could fly above the ground. But the cloud was kind of slow, and it would only go where the wind blew. He never knew how to steer the thing. So Evil Mister Fred put some bubble gum on his minions' feet, and he put a bunch of minions on top of the cloud.



Evil Mister Fred and minions on cloud.

So he said, "Minions, when I say, 'Go,' you're all going to blow as hard as you can and make the cloud go faster." [Student: What if they don't blow in the same direction?] That's the problem with minions.

And so Evil Mister Fred said, "Ready, get set, go!" And all the minions went [blows a huge breath]. And some were blowing that way, and some were blowing that way, and some were blowing that way, and the cloud didn't go any faster at all. And Evil Mister Fred said, "Argghh! Okay."



Minions with cardboard.

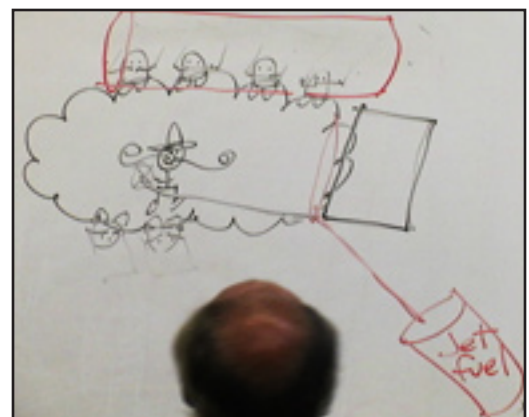
So he got some big sheets of cardboard (let's put some minions down here, too), and he gave each minion a piece of cardboard. He said, "There you go, minions. Now, you're going to make them work just like wings. When I say, 'Go,' you're going to go flappy, flappy, flappy, flappy, blow the wind, and away we'll go!"

The minions said, "All right, boss! This is good!" So Evil Mister Fred went inside, and he put his steering wheel on, with a rudder, like that. And he says, "Okay, everybody start fanning!" The minions did. They started fanning, and they were

all fanning in the same direction. But they were annoying each other. One would say, "Hey, you're fanning too close! Move away, move away!" And the other guy would say, "No, I'm not!" Whack! Whack! Whack! And he hit him on the head, and pretty soon they had a cardboard fight on the cloud, and it didn't go any better than before.

So Evil Mister Fred took that away from them, and he says, "Forget this stuff." He called the Acme Store of Everything and he ordered a jet engine. And he tied with some rope and some duct tape a big barrel of jet fuel. There's Jet Fuel. There. And he turned on the jet engine. "Now we've got real power. I've got a rudder, I've got a jet engine, we're ready to go!" Voommm!!

And he turned it on. He never studied aerodynamics very well. Now, you put a jet engine on top of something and turn it on, it tends to tumble, like this, through the air. So now Evil Mister



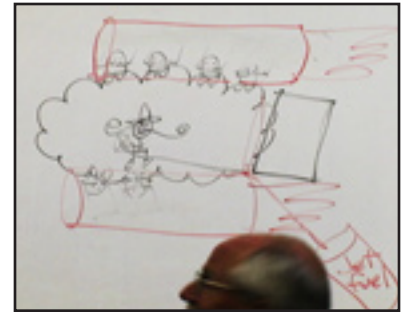
Engine on top, rudder at back, fuel below.

Fred's going, "Aaaaaaah!!!" like that. And he finally turned it off and said, "Okay, we'll fix this."

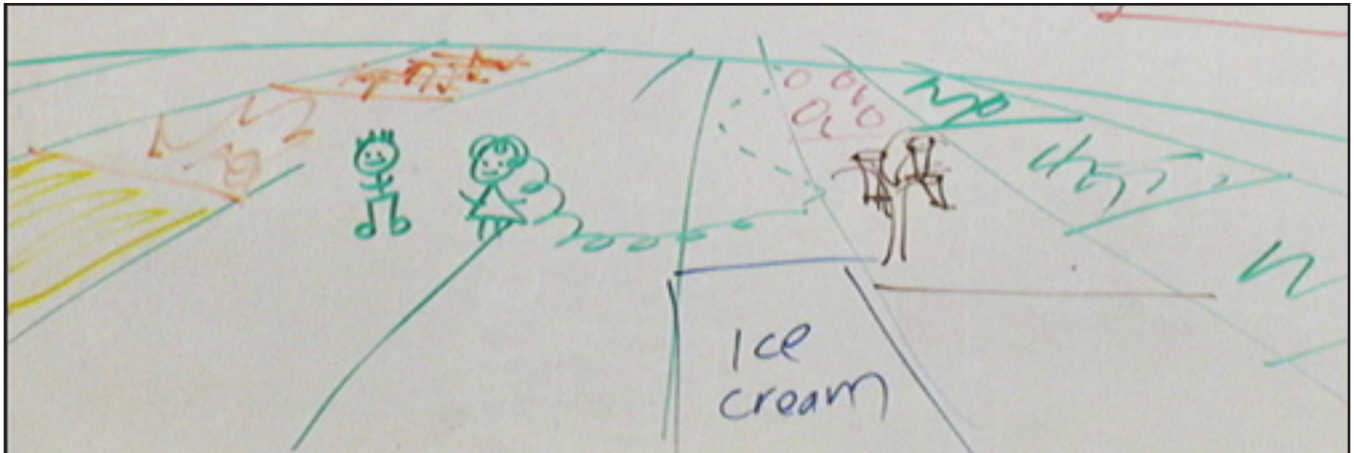
So he put another jet engine on the bottom. And now he's got a super high powered cloud. He can steer, he can go really fast -- vroom, vroom, vroom. So he said, "Now, we're ready to do some destruction."

Down on the earth, Jack and Jill were being green. They put green food coloring all over their faces, they wore green clothes, they bought green shoes, Jill dyed her hair green, and they were growing green crops.

They're growing some kind of cabbage over here, they're growing some corn over there, some watermelons over here, and some of the crops Jack didn't want green. So he had a whole field of pizza, and he was growing some orchards of chocolate milkshake trees, and he was growing some tortillas, and nachos, and some cheese. [Student: I want some ice cream!] Oh, yeah, what flavor of ice cream? [Students call out ideas.] Yeah, neopolitan ice cream. Okay?



Second engine underneath.

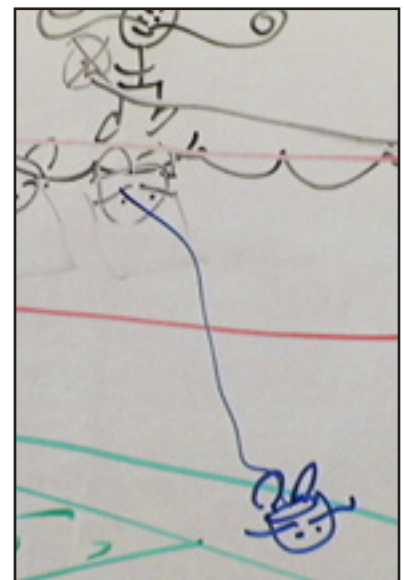


Jack and Jill and their crops.

And they would wait and wait until the crops got ripe. And when some of the crops got ripe, they would turn brown, which was a good way to tell if they're ripe -- they're not green anymore. And they'd go harvest the crops.

When Evil Mister Fred was flying overhead, he saw all this nice food growing down there. He said, "Wow! Look at that!" He could swoop down in his high speed cloud, throw out a minion on a rope, and have the minion grab whatever he wanted. So if he wanted a watermelon, he just dragged the minion over the watermelon patch -- bumpity, bumpity, bumpity, bump -- until he got a good sized watermelon. And he'd haul him back in, grab the watermelon, and throw the pieces at Jack and Jill.

And he also discovered that if he took his jet aircraft down really low, and then pointed the nose straight up, he had enough power to shoot straight up in the air. But it left behind it a big black spot on the ground,



Minion on rope.

because the flame is shooting out the back of the engine. And Evil Mister Fred said, "That's fun!" So he's making black spots here and there. And he came across one of the ripe crops and did it on the ripe crop. And when he did, the crop caught on fire -- vrooommm! And Evil Mister Fred went back and says, "Now, that's good!"

Evil Mister Fred is having fun burning up all their food. And Jack and Jill said, "Arrrghh, we've got to stop that boy!" So they called the Acme Store of Everything and they ordered a lake. It was a flying lake. And then when Evil Mister Fred would come around flying, the lake would come after him and put out the fires that he created, so it wouldn't do too much damage.

And Evil Mister Fred didn't like the flying lake doing this business. And Jack and Jill also ordered another lake and put it in the ground in case he figured out some way to stop the flying lake. And they put a cover over this lake so that Evil Mister Fred couldn't throw stuff in it and wreck it.

And Jack and Jill said, "Well, you know, we've got some water here. We might be able to stop him, but he's going to probably be able to burn crops faster than we can grow them.

If you were Jack and Jill, and you wanted to stop the Evil Mister Fred, what would you do?



Flying lake and ground lake with cover.

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: "Hero's Fountain"

Experiment, Part 1 -- Squirting Bottles

NOTE: The beginning of this experiment is missing from the video. Mr. Mac gave each student a bottle of water and a cork with two tubes in it. By attaching a drinking straw to one of the tubes and blowing in it, the students learn how air pressure can make the water spurt out from the other tube.

[Students each receive a 1/2-liter plastic bottle and a plastic cork with two holes in it. A piece of flexible tubing is already threaded through each of the holes in the cork, and the longer one extends down to the bottom of the bottle. The students also receive a plastic drinking straw, and they slip this over the end of the shorter tube. They fill the bottle with water from a bucket, put in the cork, and blow through the straw to see what happens. By blowing harder, they can make the water squirt higher.] When you're done, pour the water back into the bucket and bring the cork and the tubes back inside.



Blowing into the straw makes water spurt.

Experiment, Part 2 -- Build a Fountain

Now, you just tested out half of what Hero made. This is the rest of what Hero made -- Hero of Alexandria. We need a couple of bottles and funnel tops. There's a part of a bottle. So you've got three things that have bottle openings on them, and you've got three corks that fit bottle openings, which is a good thing.

[Teacher assembles the apparatus.] You could put one there, and you could put one there. When you're doing the experiment, try not to bend these plastic tubes too much, because sooner or later they're going to break. And we've got a bottle here, like that. There. Then you're going to need a cup. The cup is going to have water in it. One of the bottles is going to have water in it. One of the bottles is going to be empty. Of course, that means that if one is full, the other is empty. And if one is empty, the other is full. And they're both not full, and they're both not empty. Only one is full, and only one is empty.

And this cup is going to have water in it, and you're going to pour the water in there and see what happens. *[Indicates pouring water into funnel section.]* If nothing happens, you have to change something. I'm not going to tell you which bottle gets the water in it. You've got to figure that out.



Assembled fountain.

After it does whatever it's supposed to do, if it ever does do what it's supposed to do, then you're going to try to make whatever it's doing go higher. Okay. *[Students: I don't get it. I don't either.]* Good.

So you have to work with someone else. And I'll put the stuff that you're going to need here on the table. We want to make sure the tubes go where they're supposed to go. *[Teacher pulls sets of connected tubes and corks out of a box and checks them to make sure they're assembled correctly, because they've been used by previous classes.]*

Okay, if you have one of the tubes that looks like it works well, go get two bottles and one funnel and one cup and go outside. *[Students team up, gather their materials and head outside to start assembling them.]*

[Students fill one of their bottles with water, insert the corks, pour some water into the funnel, and watch what happens.] If it doesn't do anything exciting, change something.

[If nothing happens, students may switch corks to the opposite bottle. Eventually, most of them will see water spurting out from the tube in the funnel.] If yours starts to squirt water up into the air, try to make it squirt higher up into the air. No squeezing the bottle.

[At some point, when the water level is equalized in both bottles, the fountain will stop working.] [Student: Ours isn't working any more.] Oh, gee, look at the two bottles. *[Students get to figure out how to get it going again (empty one bottle and refill the other to restore the pressure).]*

And then try to make it squirt higher. *[Students seem stumped.]* Well, guys, you could just stand there and look at it and tell it to go higher, but you might want to try something. Try moving something in some way. *[Student picks up one bottle and raises it and lowers it. The level of the spurting water changes, going higher when the second bottle is lower than the one with the funnel on it. When other students hear one group announce their success, they'll come and take a look at it, then go back and try to make theirs work the same way.]*

Okay, you need to take them apart and leave all the pieces here. Pour the water back in the buckets.



By trial and error, this student discovered that lowering one bottle made the fountain squirt higher.

Experiment, Part 2 -- Followup

[Back inside the classroom, the Teacher shows students how the tube and cork assembly works.] If you follow this tube, it goes down and connects to this hose, and the hose, at the end, dipping right into this blob of water. And this tube comes out over here. If I was to blow on this tube, what would happen? *[Students: Water would squirt out.]* It would come out the top. *[Students: Do it! Do it!]* Okay. *[Instructor blows into one end of the tube, and water squirts out from the funnel.]* That's just like your squirt bottles that you were using before, right?

Now, in order for it to squirt, air has to go in here. Where does the air come from? *[Student: The other bottle!]* The other bottle, okay? Now, in order for the other bottle to create pressure, water has to fill this bottle to create the pressure so that the air comes out, right? *[Student: Pour water into the top!]* Yeah! *[Student: It's a big cycle!]*

That guy -- whoever invented this -- Hero didn't invent it, but whoever invented this was really brilliant. You know, they didn't want to just have it because it looked cool. They wanted it for parties. And they didn't use water. They used wine. *[Teacher pours water into the funnel to get the fountain going.]* So they could have this thing going, and people could put their wine glasses there, and they could fill their wine glasses with wine. And they used really big barrels, so that this thing would run all day long with the wine spewing out like that.

[Student: Raise the bottle that doesn't have anything in it up.] *[Teacher raises the air bottle and the level of the fountain goes down.]* *[Student: So if they wanted to turn it off, they just put it up.]* Yeah.

[Teacher indicates the full bottle.] What if I raise this one up? *[Student: It'll go higher.]* *[Teacher raises the full bottle, and the fountain goes higher.]*

So in those days, they didn't have electricity, but they had good brains, so they figured out how to do things without the electricity part.

[Indicates cork in the empty bottle] If I take this cork out, will everything stop? *[Students: Yes.]* *[Teacher pulls out cork, and the fountain stops.]*

[Student: What will happen if you take out the water cork?] What do you predict will happen if we take out the water cork? *[Students: It'll stop. It'll go weird.]* It'll go weird? *[Teacher starts the fountain going again, then pulls out the cork from the water bottle. The fountain stops.]* Did you hear it? Air pressure in there is what makes it squirt up, so no air pressure, no stream.



Raising the air bottle turns off the fountain.

Experiment, Part 3 -- Upside-down Water

We've got time for one more quick thing. *[Teacher brings out a glass canning jar with a piece of pantyhose stretched over the top and held in place with a rubber band.]* Here is a jar, glass, with a piece of cloth over the top. And I'm going to pour water into the jar. Will water go through the cloth into the jar? *[Students: Yes.]* *[Teacher pours water into the jar and it goes right through the cloth.]* It's a nice way to stop the splashes. *[Teacher fills jar completely.]* There, it's full.

Now, will this amount of water fit into this cup? *[Holds up a clear plastic cup whose capacity is less than the jar.]* *[Students: No. Yes.]* Okay, here we go.

Water pours through the fabric.





Only a small amount of water pours out.

[Teacher quickly upends the jar directly over the cup, and only a small amount of water comes out.] See? It fits!

[Teacher holds jar upside down over the head of one of the students.] What do you see up in there? See any bugs in there? There's a little fly in there. Why don't you poke it? [Student pokes the cloth and a little bit of water spills out. Then the Teacher goes around and lets each student poke the upside-down jar while the Teacher holds it over their head.] Why does a little poke produce water?

Now, suppose you had this full of wine and you were serving wine at a party, and you're holding it upside down like this. You go from cup to cup and

you want to give them some wine. You tilt the bottle a little sideways, and you give them some wine. *[Water pours out of the jar in spite of the cloth when it's held at an angle.]* And then to stop it, you turn it upside down. *[Teacher turns jar completely upside down again, and the water stops flowing.]* Or you could turn it that way *[turns jar right side up]*, but that's not as much fun. Everyone knows that.



Hold jar at an angle to pour.

[Now that the jar is empty, the Teacher tries to pour more water into it, but very little of it penetrates the cloth. Most of it flows off the sides.] How come it poured all over the outside that time? Because this was all wet, and the air can't get through the wet cloth as easily. When I started, it was dry. Now we need an ending for our story.



Student pokes cloth to make water come out.



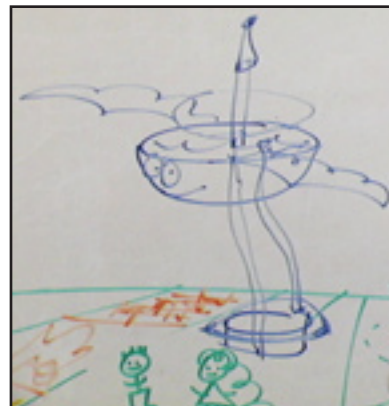
Water won't pour through wet cloth.

End of Story

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

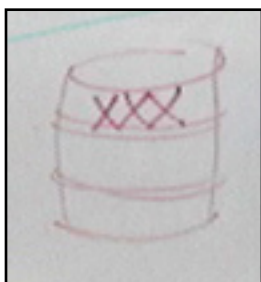
So Evil Mister Fred is zooming around on his jet-powered cloud, burning up Jack and Jill's fields. And they try to put out the fires as quick as they can with the flying lake, but it's not working. And they decide to put some hoses between the two lakes. So they put a fountain hose just like you guys had, and there's a tube going down to the bottom of that one. And then another one here. You have to have kind of a funnel shape here with a tube coming into this one, right to the top of that. Okay? So they created their fountain in the air, and they thought, "Maybe Evil Mister Fred will fly through the fountain, the water will get in his jet engines, and they won't be able to work any more. And he won't be able to burn up our crops."

Well, Evil Mister Fred saw that and he said, "Huh! They're trying to trick me. Those rotten guys! I'll show them." He went vroooooommm -- he's burning up everything good. And Jack and Jill said, "Well, that didn't work. We'll try the opposite technique." They said, "Hey, Evil Mister Fred! We've got a gift for you!" And he said, "What is it this time?"



Jack and Jill make a fountain from the lakes.

And Jack and Jill said, "We called the Acme Store of Everything and got you some new jet fuel." And Evil Mister Fred said, "You what??" And Jack and Jill said, "Hey, we give up. You're too powerful for us. You're just going to burn up everything. Here's a gift. Have some jet fuel."



Rocket fuel

Well, they ordered it from the Acme Store of Everything, but they didn't know which kind of jet fuel his jet engines used. So they just got the best money could buy -- triple XXX jet fuel. Evil Mister Fred swooped down and he says, "Boy, those guys are dumb!" And he filled his barrel up with their triple XXX jet fuel. Jack and Jill thought, "Now, we gave him a gift. He's going to be nice."

Well, he wasn't nice. He got the jet fuel in there and he said, "So long, suckers!" Vroooooommmmm! And took off. Well, there was a little of the old fuel still left in the hoses. So when he took off, he took off at the regular speed. And then Evil Mister Fred said, "Aw, now, there's a nice crop. I'll go burn that one up." Well, now all the old fuel is used up, and some of the new fuel was just coming in when Evil Mister Fred swooped down, turned it over, and hit the burners, full speed. Well, the triple XXX jet fuel was so powerful, his jet went vroooooommm! -- took off so fast, his ears stretched straight down to his ankles, his eyes went to the back of his head, and Evil Mister Fred was smashed onto the floor like a pancake. And the rocket took off through the atmosphere, past the moon, past Jupiter, clear to Pluto. And everybody 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.