



Teacher's Guide for: **Catapults**

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

[00:03] (These numbers are **time codes**, so you can refer back to the video.)

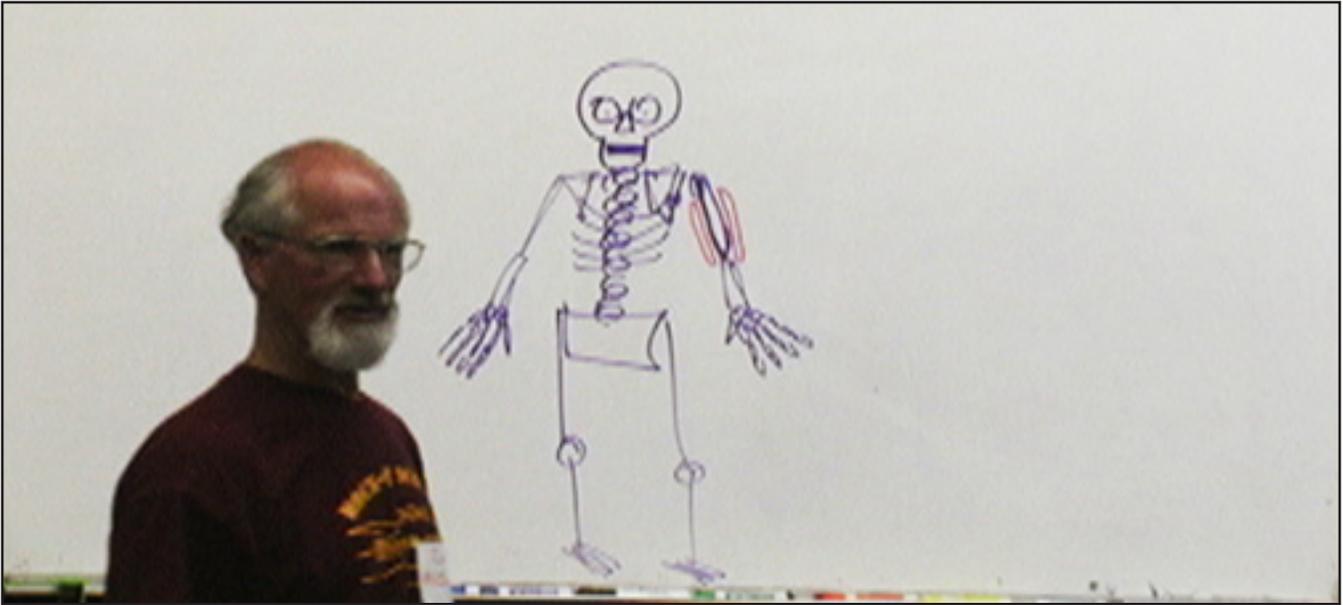
Catapults
A Rock-it Science Lesson
Filmed June, 2009

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Quick Recap



Intro:

- Teacher draws a skeleton, including two muscles of the upper arm.
- Muscles can't push, they can only pull.
- The muscle on the top of the upper arm can pull the arm to make it bend. The muscle on the bottom of the upper arm can pull to make it straighten out again.
- The experiment will try to duplicate what muscles and bones do, to launch something across the room.

Experiment -- Build a Catapult:

- Pass out supplies to students and turn on glue guns.
- Tell students the objective is to make a grape fly through the air as far as possible.
- DO NOT show students a finished catapult, nor give any instructions about how to build one. Let them spend some time trying things out.
- After about ten minutes, if some students are still struggling to get started, give them a QUICK glimpse of a finished catapult shooting a grape. DO NOT leave the catapult in sight, and do not let the students examine it. The quick glimpse is just to give them a very general ideal of how a catapult can be made.
- If even one student gets it working, the others will start to copy the idea. But each one should look different in the way it's constructed.
- Once they get their catapult working, let them try shooting a grape, making adjustments as needed in order to make the grape fly as far as possible.



Equipment List: "Catapults"

Items needed for Teacher:

- Table cover
- Power strips
- Wire cutter (for pipecleaners)

Items needed for Students:

Consumables (per student):

- Craft sticks, about 50 ea.
- Cardboard square, approx. 6" x 8" (size isn't critical, but sides should be longer than a craft stick)
- Rubber bands, 5-6 ea.
- Cups, plastic souffle, 2-oz, at least 1 ea. Some students may want to use more.
- Pipecleaners, cut in half, about 6 ea.
- Plastic grapes, 3 ea.
- Glue sticks

Other (per student):

- Glue guns
- Scissors

Prep Work:

- Cut individual grapes from bunch.
- Cut cardboard into squares
- Cut pipecleaners in half
- Put groups of 50 craft sticks into ziplock bags



Craft sticks, rubber bands, cardboard squares, plastic cups, plastic grapes, power strip, glue guns, glue sticks.

Story Quick Recap



Part 1:

- Jack and Jill decide to move to the wilderness, sleep in a cardboard box, and live off the land. There wasn't much to eat, but a squirrel showed Jill how to eat the nuts from a pinecone. Jack tried eating dirt, but he didn't like it.
- Jack ordered some chocolate chip cookies from the Acme Store of Everything, but Jill threw them in the river, because that was cheating.
- They decided to make their own cookies. They found some bushes that had little grains growing on the top and saw birds eating the grains. They smashed the seeds with rocks to make flour.
- There was a tree with a beehive on it, so they took honey from the hive. And they found a blueberry bush and picked the berries. They made an oven out of rocks and mud and baked blueberry cookies in it.
- People in a nearby town smelled the cookies baking. They came and asked Jack and Jill for a cookie and ended up eating all of them.
- The next day, Jack and Jill made more cookies, and this time they charged a hundred dollars each, and people were happy to buy them. The following day, they charged a thousand dollars each, and people still bought them.
- Evil Mister Fred heard that Jack and Jill had the world's best cookies and lots of money, so he ordered his minions to carry him on their heads to Jack and Jill's place. During the night, they stole all the cookies and money.
- In the morning, Jack and Jill followed the minion footprints to where Evil Mister Fred and the minions were sleeping after eating all the cookies. They took back the money and whatever was left of the cookies and went back to their place.
- Evil Mister Fred had his minions cut down trees and build a wall around their campsite, with a locked door. Then they went and stole Jack and Jill's cookies and money again.
- When Jack and Jill came, they couldn't get in. But they built a campfire just outside and accidentally caught the wall on fire, so they ran in and took their cookies and money back.

Story Quick Recap (cont.)

- Then Evil Mister Fred made a wall out of stone, and Jack and Jill couldn't get in. But a gopher helped them by burrowing under the wall and opening the door so they could get their stuff.
- Next, Evil Mister Fred had his minions dig a moat and fill it with water and vicious animals. At night they came and stole Jack and Jill's cookies and money again, then came back inside their fort and raised the drawbridge so Jack and Jill couldn't get in.



Ending:

- Jill braided her hair into a rope, tied her hair to Jack's shirt, and told him to climb to the top of a tall tree that was near Evil Mister Fred's fort. Then Jack tied the end of Jill's hair to the top of the tree.
- Jill pulled on her hair until the tree bent way down. Then she cut her hair with a pocket knife.
- The tree sprung back, flinging Jack right into Evil Mister Fred, hitting him in the face. He fell on the ground, out cold.
- The minions were running around in a panic, hitting each other with their baseball bats, and hitting Evil Mister Fred, too.
- Jack grabbed the money and cookies, lowered the drawbridge, and ran away.

Transcript: Introduction

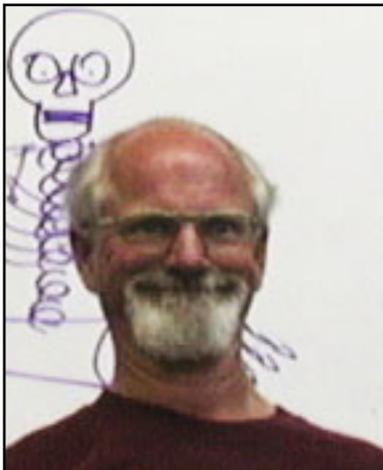
[00:11] If you take all of the skin and the muscles and such off of someone, you end up with a skeleton. And they've got a mouth, they've got big eyes, a nose, there -- like that. And they've got a spine, they've got some hips, and they've got some bones, kneecaps, and some feet. There's some shoulderblades out there, and some armbones, some little armbones, and there's some fingerbones. Oh, yeah, ribs. [Student: Don't forget the heart.]

No heart. Heart got dissolved away. You've got a skeleton, and all these bones can move, luckily, otherwise we'd be stuck. We'd just be "ah-hhh!" [stands stiffly, immobile]. And the ones we're going to use today are like the armbones here, and the shoulderbones. We can throw stuff. People are really good at throwing stuff.

And muscles. There are some muscles on the top and some muscles on the bottom. There's a muscle up here [indicates upper arm of skeleton], and there's a muscle down here [indicates lower side of upper arm].

Muscles are kind of weird. Muscles can't push, they can only pull. So if you want to make your arm go like that [flexes arm], the muscle on the top pulls on this bone -- urrrp -- and pulls it up. If you took away the muscle on the bottom, you wouldn't be able to straighten your arm again. To straighten your arm, the muscle on the bottom has to pull, and it goes brrrp! And pulls it back out again. So you need a puller up here and a puller down here to move your arm.

If you want to smile, there's a whole bunch of muscles in your face that all move to make you smile. And just to move like this [steps sideways], you might be using ten or twenty different muscles to move around. Today we're going to be trying to duplicate what muscles do, and bones, to launch something across the room. [Student: Catapults!]



You use a whole bunch of muscles to smile.

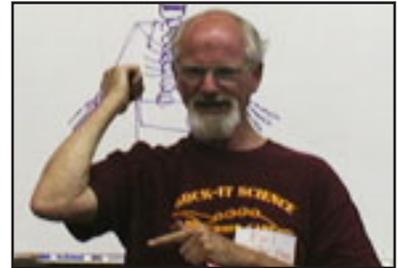
No, we're making dogapults. It's like a catapult, but you use dogs instead. It could be an octopult if it shot octopuses.

[Students: Octopi!!] No, actually, if you go to the Monterey Bay Aquarium and you talk to the lady in charge of the octopuses. I asked her, "Shouldn't they be octopi?" And she said, "No, it's octopuses."

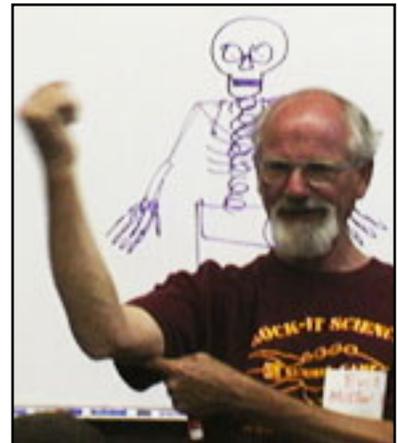
Now, we need a crazy story and then we'll do some experiments.



Muscles on upper arm



Flex arm



To straighten your arm, the muscle on the bottom has to pull.

Story: "Rescue the Cookies!"

[03:29] Let's suppose that Jack and Jill decided to leave their house and go live in the wilderness. And they were gonna live off the land. Jack says, "Yeah, I'm gonna go out there, I'm gonna eat dirt and I'm gonna eat bushes. I can survive off of dirt and bushes." And Jill said, "Okay, you can live off of dirt and bushes. I'll think of something else when we get there."

So we need some land for them to live on. Let's make the land red. And they need to live in a house of some sort, so they found a cardboard box blowing around down there. They're gonna live in a cardboard box. And they decided to wear bushy shoes and make clothes out of bushes.

And Jack said, "All right, we've got a house, we're out here in the wilderness, there's got to be water here somewhere." Let's put some water there. We'll give them a dirty river. You know how rivers aren't perfectly clean. There's a little bit of sand and mud in the water.

And Jill said, "Yeah, this is great. We can do this. We can live out here." The first day, Jack was pretty good. He ate some bushes. He didn't like the dirt, so he didn't eat the dirt. And Jill was searching around, and she found a tree that had some pine cones on it. So Jill was gnawing on a pine cone, and a squirrel said, "What are you doing?" Jill says, "What does it look like I'm doing? I'm eating a pine cone."

And the squirrel said, "You shouldn't be eating a pine cone." And Jill said, "But I saw you eating a pine cone." And the squirrel said, "I spit it out." Jill said, "Why do you eat a pine cone and then spit it out?" And the squirrel said, "Weren't you watching?" Jill said, "Yeah." The squirrel said, "There's little old nuts in between the pine cone leaves. I eat the little nuts and spit out the rest." And Jill said, "Ohhhh! Okay!" So then she started searching for the little nuts and she was eating those.

But they weren't doing too well. So Jack called the Acme Store of Everything and he ordered some cookies. And the cookies came, and Jill said, "No, Jack -- you don't get to have cookies. You've got to make your own stuff." Jack said, "Oh, but they're chocolate chip!" And Jill said, "Sorry, no." And threw them in the river and the fish ate them all up.

And Jack and Jill said, "Okay, we're gonna make our own cookies." So they found some bushes that looked like weeds that had little grains growing on the top, and they saw the birds eating the grains. They said, "Okay, we'll collect some of those." And they stomped on them, the seeds came out of them, and they smashed them with rocks, and made white floury stuff.

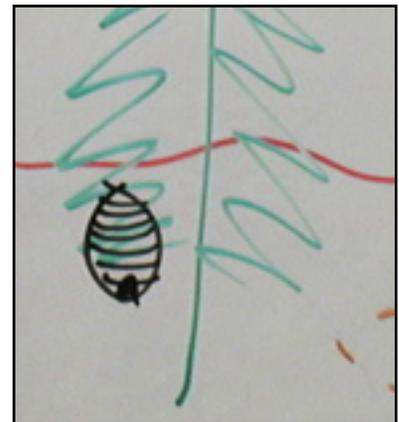
And they found another tree growing out there. And, oh yeah, there'd have to be something like a beehive in here. And they took the honey out of the beehive. *[Student: Did the bees chase them?]*



Jack & Jill with box and river.



Weeds with grains, and pine tree.



Beehive in pine tree

Yeah, and the bees chased them all around. So they had something sweet. And the weeds that look like that, you can make flour out of. So they could make flour and cake stuff. And they need something like berries. You could find a berry bush out in the wilderness. Is there anything else you could find out there to eat? *[Students: Cherry trees, huckleberry, pear trees, blueberry trees, orange trees . . .]* Let's do the blueberries.

So now they said, "Okay, we've got flour, we've got water, we've got honey, and we've got blueberries. Let's make some blueberry cookies." So they made blueberry cookies. And they made an oven out of rocks and mud, like the indians used to do. And fire. And it got really hot, and they put the cookies in there and cooked their cookies.

While the cookies were cooking, of course, cookies made their cookie smell. And the cookie smell started to drift over the landscape. And far, far away there's a little city. And the people came outside and they went *[sniffs]* "Mmmm -- cookies!" And they all ran over to Jack and Jill's place and they said, "Can we have a cookie, please, huh, can we, can we, can we, can we?"

And Jack and Jill said, "Well, of course you can have a cookie. Have a cookie." So they all ate all of Jack and Jill's cookies. And they ran away saying, "Thanks, that was great." And Jack and Jill said, "But there was none for us. What are we gonna do?" So they made more cookies. And they said, "Tomorrow when they come, we'll make them pay for the cookies."

So the people came over the hill again, running in, and they said, "Oh, boy, more cookies!" And Jack and Jill said, "Yep, more cookies. A hundred dollars each." And they said, "All right! Here's five hundred dollars, I want five cookies." Another person said, "Here's a thousand dollars, because I want ten cookies." And they all bought all of Jack and Jill's cookies. Now Jack and Jill had a huge pile of money and no cookies. So the next day they made even more cookies. *[Student: A thousand each.]*

Yeah, and said, "A thousand dollars each." And the people bought all their cookies again. Next day, Jack and Jill made even more cookies, and word got out. These are the world's best cookies, and Jack and Jill are rich.

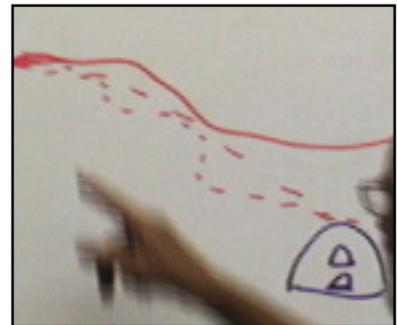
Of course, Evil Mister Fred heard about it. And Evil Mister Fred climbed on top of his minions and said, "Minions, go on the march!" And the minions started marching, and they said, "Where to, boss?" And Evil Mister Fred said, "We're off in search of treasure." So here



Blueberry bush



Jack and Jill build an oven.



People came from the city over the hill when they smelled the cookies.



Jack and Jill had a huge pile of money from selling the cookies.

he is, standing on top of the minions. And the minions don't hike very fast, especially with Evil Mister Fred standing on their heads. And by the time they got to Jack and Jill's place, it was dark. Jack and Jill were asleep [makes snoring sounds]. And Evil Mister Fred said, "Shhh." And they stole all of Jack and Jill's money, and all Jack and Jill's cookies, and danced off.

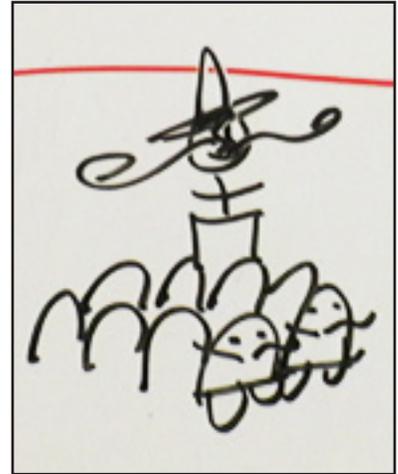
And then in the morning, Jack and Jill woke up, and there were no cookies, and no money. And they looked on the ground and there were minion footprints everywhere. And they said, "Ohh!" So they followed the minion footprints. And they came to where Evil Mister Fred was. And there was Evil Mister Fred and his minions all chubbed out because they ate the cookies. And the money was everywhere. So Jack and Jill took whatever was left of the cookies and the money back again, and went back to their place, and said, "Well! Those guys stole our stuff!"

Well, when Evil Mister Fred woke up, he said, "Hey, where's the money? Somebody stole the money we stole! That's not right! Ohhh!" So he said, "Minions, make a wall." So they went and cut down big trees, and they made a big wall all around their campground. Huge wall. When they were all done, one of the minions said, "Boss, how do we get out?" Because they forgot to put a door. And Evil Mister Fred said, "Arrgh, do I gotta do everything?" And he cut a door in the wall. And they had a door.

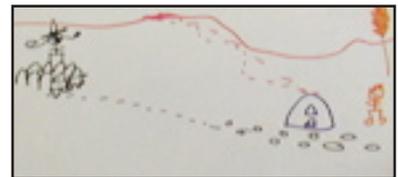
And that night, Evil Mister Fred and the minions went back to Jack and Jill's place. Jack and Jill had made new cookies, and Evil Mister Fred stole them again, went back to his fort, went inside, closed the door and locked it. Of course, Jack and Jill followed the footprints again, went back there, and saw the tall wall, and said, "Oh, no -- we can't get in! He stole all of our money and our cookies and we can't get it back."

And they sat down by the wall and began to cry. And while Jack was crying, it got dark, he couldn't see, so he lit a match, and he made himself a little campfire there. And the wind came up, and the campfire got a little out of hand and burnt down Evil Mister Fred's wall. There were flames everywhere. And Jack and Jill said, "Woohoo! We can get in!" And they went in and took their cookies and their money back again and ran back home.

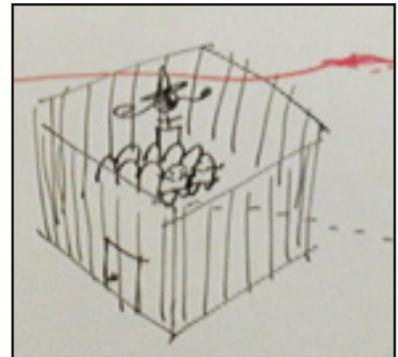
Evil Mister Fred woke up again the next morning and his wall is burned down. And there's no cookies. And there's no money. So he says, "Minions, we need a better wall." So they made a wall out of stone, and they polished the outside so it was smooth as smooth could be. They made a



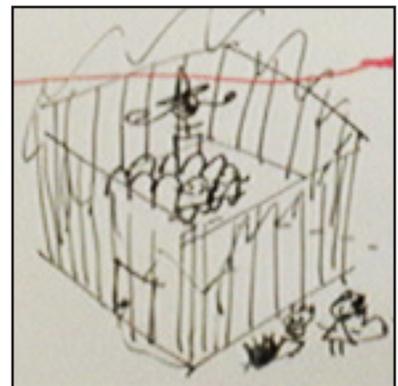
Evil Mister Fred on the minions' heads.



Minion footprints everywhere



The minions built a wall.



Jack's campfire burned down Evil Mister Fred's wall.

big wooden door on this wall. And of course, they went back and stole Jack and Jill's cookies and their money again.

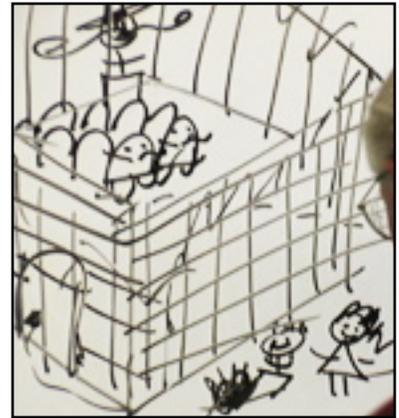
And the next day Jack and Jill came back and they looked, and they said, "Oh, no, a stone wall. It won't burn. What are we gonna do?"

And Jill was sitting there minding her own business, and a little gopher came up. And Jill said, "Gopher, it's so sad. We can't get in and get our money back that Evil Mister Fred stole. And the gopher said, "Never fear, I'll help you out."

So the gopher dug down into the ground. Next thing they heard was a tiny little "knock, knock" on the big wooden door. And Jack and Jill said, "What was that? You're not supposed to knock on the inside of a house." So they went over to this door and they grabbed the doorknob and rrrp! -- it swung open! The gopher had dug inside and unlocked the door! So Jack and Jill stole their money and their cookies back again and they went home.

And Evil Mister Fred woke up the next day. No cookies, no money. And the door was wide open. And he said, "Arrgh!" So this time he had his minions dig a deep pit all the way around the wall. And they filled the pit with water, a deep trench I guess you could call it. And they put snakes in there, and they put sharks in there, and octopuses in there, octopis too, if you want an octopi. It could be an octocake. And they made the door be like a bridge, so the door would come down and go across the trench. The drawbridge.

And of course that night they went out and stole both Jack and Jill's cookies and their money. And Jack and Jill came and they looked at this and they said, "Oh, no. It's got a moat. It's got vicious creatures. It's got a stone wall. The door is closed. We can't get in. This is really sad."



Evil Mister Fred rebuilt his wall, making it strong and smooth.



A little gopher offered to help.



Evil Mister Fred built a moat and filled it with dangerous animals.

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.)

Okay, we'll leave this "To be Continued . . ."

Experiment: *Catapults*

[17:42] Well, you're gonna be making something that -- the objective is to throw a grape. The idea is to make a machine that will throw a grape. You'll each get grapes. Now, in the past, people have tried it all sorts of ways. What you're gonna get is a bag of sticks. You get a piece of cardboard and some sticks and some glue. And several rubber bands, as many rubber bands as you like. And some small cups. Luckily, the grape fits in the cup. The idea is to make the grape fly through the air as far as possible -- kerchugh! -- and land somewhere, with the stuff that you have.

You can do it any way you want. You can use rubber bands if you want. Okay? And you'll use glue guns to glue it all together any way you like. About halfway through, if you haven't got any good ideas, I'll show you some samples of what other kids have made. But up until then, we'll want to see if you can cook up anything. You'll get a bag of sticks, about forty or fifty sticks in a bag. *[Places cover on table. Places power strips on table, plugs in glue guns, one for each student. Passes out ziplock bags containing craft sticks.]* And here are the rubber bands -- these are your muscles. *[Passes out rubber bands, grapes, two cups per student, and some short pipe cleaners. Students start building.]*

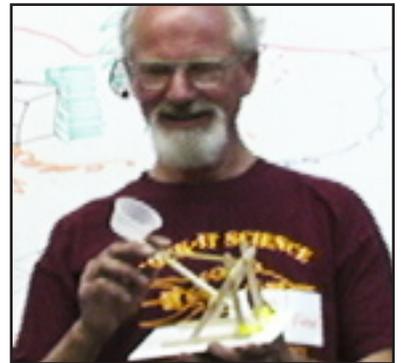
A catapult is usually an arm, like a body's arm. How would you throw a grape with your arm?

[After students have been building for about ten minutes] Now, is there anybody that has no idea of where to start? Okay, if you have an idea of where to start, close your eyes. If you have no idea of where to start, keep your eyes open. *[Teacher takes out a sample catapult from behind his back, quickly triggers it a couple of times to fling the grapes, then quickly puts it out of sight again. Students are NOT allowed to examine the sample catapult, so they won't copy it.]*

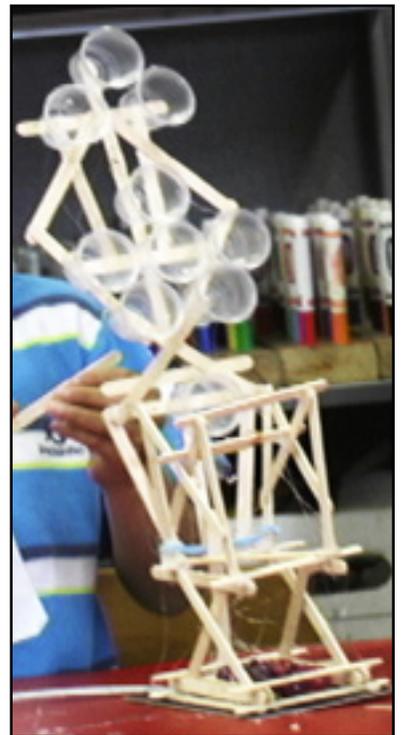
[Students continue building, then test their catapults by flinging grapes.]



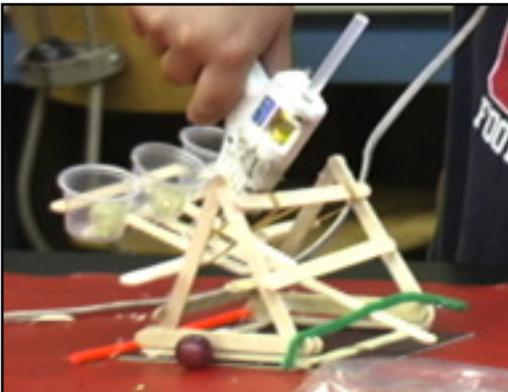
Pass out supplies and plug in glue guns.



Show sample catapult if needed.



(Above & Left) Each student's catapult comes out different.



End of Story

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

[31:26] So Jack and Jill couldn't get in because Evil Mister Fred had made his magnificent castle wall with a moat around it, wild creatures in the water, smooth surfaces. And they said, "Oh, no, what are we gonna do?" And Jack looked around, and Jill looked around, and Jill said, "Jack, there's one tree still standing." And sure enough, there was one tree standing right there. And Jack said, "Well, what good is that?" And Jill said, "I have hair, don't I?" And Jack said, "Well, of course you have hair." And Jill said, "Fine. Go climb the tree." And Jack said, "Why?" And Jill said, "You'll see. Just go clear to the tippy top and hang on tight."

Here's Jack hanging on for dear life. While Jack was climbing, Jill had tied to his shirt some of her hair. And she wove her hair into a rope, and she said, "Jack! Now tie my hair to the tree." So Jack tied the hair to the tree. And now here's Jill going down. And there's Jill.

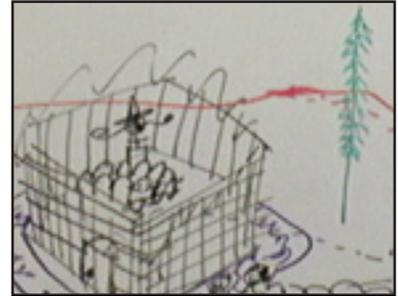
And Jill said, "Okay, Jack! Hang on!" And she started pulling on her hair. As she did, the tree started bending backward. And Jack is saying, "Jill, what are you gonna do? This doesn't look good. I don't like this." And Jill said, "Well, I think it'll work." And Jill pulled out her pocket knife and cut it. And Jack went, "Ahhhhhhh!"

And Evil Mister Fred heard the screaming. And he looked up, and just at that point, Wham! He got hit in the face with flying Jack. And Evil Mister Fred fell on the ground, out cold! And the minions said, "Boss! Where's Boss? We can't see the Boss!" And the minions are all running around, just being crazy because they're minions and they've got their baseball bats, and they're hitting each other, and they're also hitting Evil Mister Fred.

And Jack ran over, grabbed all the money and all the cookies, went to the door, put down the drawbridge -- foop! And ran away, and everyone lived happily ever after, except for Evil Mister Fred.

[34:10] **End of Lesson**

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



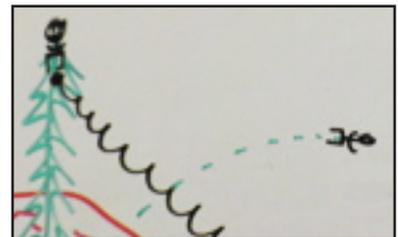
There was one tree left near Evil Mister Fred's castle.



Jack climbed to the top of the tree.



Jill wove her hair into a rope.



The tree bends back.



Jill cuts the rope with a pocket knife.